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The Effect of Alcohol Outlets and Sales on Alcohol-Related Injuries Presenting at Emergency Departments in Perth, Australia, from 2002 to 2010

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Statement

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Michelle Bridget Hobday

Date:

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Abstract:

Introduction: Many studies have examined the effects of alcohol outlet density on alcohol-related harms including assault and road crashes. There is, however, a paucity of research establishing the effects of alcohol sales and differences between alcohol outlets on alcohol-related harms, especially on injury cases presenting at Emergency Departments (EDs). This study aimed to examine the effects of these outlets and wholesale alcohol purchases on alcohol-related injuries presenting at EDs.

Methods: A surrogate measure of alcohol-related injuries was verified using each year of ED data, and applied to the dataset. The relationship between place of residence and place of alcohol purchase was verified by undertaking an online panel survey. Volumes of alcohol sales for each postcode and suburb were obtained from the Drug and Alcohol Office, Government of Western Australia. Using injury and outlet data at postcode-level, circular buffer zones were created around the centre of postcodes in which injury cases resided. Outlets were then coded according to their location within multiple buffers. Demographic and socio-economic characteristics of the postcode populations were utilised. Distance from the Perth CBD was a further predictor incorporated in the analysis. Physical alcohol availability was measured using: number of outlets by licence type; trading hours; and wholesale purchases of beer, wine and spirits (a proxy for retail sales). Using negative binomial regression with random effects, models were created to describe the relationship between the indicators of alcohol availability and alcohol-related ED injury.

Results: Analyses showed that higher pure alcohol sales per off-premise outlet and higher counts of on-premise outlets were significantly associated with higher numbers of alcohol-related injuries presenting at EDs. These results were demonstrated at both postcode- and suburb-level. The strength of the association varied depending on the size of the buffer zone used, with the strongest associations evident when total outlets and sales in postcodes and suburbs were used. Postcodes and suburbs with higher proportions of unemployed residents and residents of Indigenous origin were also significantly associated with higher numbers of alcohol-related injuries.

Conclusion: With off-premise outlets, volume of alcohol sales was a more important predictor than the absolute number of bottle shops. However, the count of on-premise outlets (and potentially the clustering of these outlets) was of more significance than the volume of

sales, pointing to the negative effects which on-premise outlets have on the neighbourhoods surrounding them. The results suggested that both off- and on-premise outlets were associated with alcohol-related injury but that alcohol control policies need to take cognisance of their different mechanisms of action to effectively reduce harm.

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1 Introduction

Since prehistoric times, alcohol has been used for medicinal, religious, hygienic and recreational purposes [1]. In Europe and America, alcohol was considered a healthy alternative to drinking polluted water up until the late nineteenth century. Until the latter part of the twentieth century, it was used as a tonic, as a cure for fevers and infections, and as an anaesthetic [2]. Alcoholic beverages are still used in many cultures to commemorate important milestones in peoples' lives including births and weddings, religious rituals such as the Catholic mass and traditional social rituals [1].

Currently, consumption of alcoholic beverages is primarily a leisure activity, used as a means of relaxation and to sate thirst, both alone and in groups. Alcoholic beverages are intoxicants, and, in some social situations and religious rituals, intoxication is seen as acceptable and pleasurable. However, alcohol is a drug and a toxic substance. Both binge drinking (acute intoxication) and chronic exposure to high doses of alcohol (alcohol dependence), may lead to harmful medical and social consequences [1].

Beliefs about the causes of alcohol misuse have changed over the last 150 years. In the period from the 1880s onwards, alcohol dependence and intoxication were seen as signs of moral decay, making retribution the responsibility of the clergy and the law. The temperance movement aimed to remove or reduce the 'scourge' of alcohol use [3].

In the first half of the twentieth century, alcohol misuse began to be perceived as a medical problem. 'Alcoholism' was regarded as a disease, and, by the 1960s, treatment was considered more appropriate than legal punishment. The problem with alcohol was the person not the bottle [3].

In the second half of the twentieth century, the World Health Organisation (WHO) introduced the problem of alcohol misuse into the public health arena. Two seminal publications were sponsored by the WHO: "*Alcohol Control Policies in Public Health*" (1975) [4], and "*Alcohol Policy and the Public Good*" (1994) [5]. Alcohol misuse was understood to be not merely an individual problem which could be 'treated' but as a population-based problem which could be managed using population-level interventions. The focus on the problem shifted from the person to the bottle, from the alcoholic to all drinkers of alcohol [2].

1.1 Rationale

Australia is a country with a reputation for heavy drinking [3], as well as associated alcohol-related harm including violence [6], antisocial behaviour [7] and chronic disease [8]. Alcohol consumption accounted for 18.1% of Disability Adjusted Life Years (DALYS) due to injury and 2.3% of all cause DALYs in 2003, making it an important public health issue [9, 10]. Both Australian and international research has demonstrated that the greater availability of alcohol in the community is positively associated with levels of consumption and alcohol-related harms [1]. This thesis explores how the physical (and economic) availability of alcohol is associated with alcohol-related injury in Perth, Australia.

Physical availability of alcohol is dependent on, among other factors, the number of outlets per geographical area (outlet density), the type of outlets, the volume of sales and the number of hours that outlets are open for business. Previous international and Australian research has focused primarily on the relationship between alcohol outlet density, and violent crime and road crashes. The studies used data from police records [11-17], hospital admissions or discharges [16, 18, 19] and surveys [20, 21]. These studies have confirmed the link between alcohol outlet density and associated harms. Few studies have, however, incorporated total alcohol sales or the level of consumption as additional measures of physical availability. Studies including both sales and counts of outlets suggest that associations with harm vary between on- and off-premise outlets, and between urban and regional areas [22, 23].

Studies of alcohol-related injuries presenting at EDs have focused on showing a causal link between alcohol and injury, including a dose-response effect between alcohol consumption and injury [24, 25]. However, research linking outlet density with ED presentations is rare (exceptions include [26] and [27]), and there are no studies including both counts of alcohol outlets and their sales, and ED presentations.

Western Australia is one of the few states in Australia (and across developed countries) where sales data is accurately collected and available for use in research. While previous Western Australian studies have explored the relationship between counts of outlets and their sales, and alcohol-related harm, they have used a cross-sectional design and larger geographic units [22, 28, 29]. This longitudinal study will use counts of alcohol outlets and wholesale sales of alcohol made to licensed premises (referred to hereafter as alcohol sales) at postcode- and suburb-level in Perth, and explore their associations with alcohol-related injury.

Another aspect of availability is the trading hours of alcohol outlets. Clear evidence demonstrates the effect of extended trading hours at Perth alcohol outlets on road crashes and assaults [30]. However, no research to date has included all three measures of alcohol availability (counts of outlets, sales and trading hours).

1.2 The study area: Perth Metropolitan Area

Perth, the capital city of Western Australia, is located on the south-western coast of the state. Situated more than 2,000km from Adelaide (the nearest Australian capital city), Perth has been called the most remote capital city in the world.

For approximately 45,000 years, the area now known as Perth has been inhabited by the Noongar[1] people [31]. The land where Perth stands today was known as *Boorlo* and Fremantle as *Walyalup* [32]. Dutch and then French explorers sailed around the West Australian coast, but it was not until 1829 that a settlement of persons of European heritage was established on the Swan River [33].

The settlers first sighted Western Australia on 1 June 1829, which became known as Foundation Day [33], and later as Western Australia Day. On 12 August 1829, Captain Stirling, accompanied by senior officers and troops, selected the site for Perth. The foundation of Perth was proclaimed with the cutting of the ceremonial foundation tree by the wife of an officer [32]. The port town of Fremantle was established simultaneously. As the area continued to develop, the British took over the land occupied by the local Noongar people, leading to conflict between the two groups [32].

Perth grew slowly through the nineteenth century. In the latter half of the century, convict labour was sent to the area to help to develop the settlement. The Gold Rush in Western Australia in 1892 led to rapid growth of the region [33]. In the first half of the twentieth century, infrastructure continued to develop. With the discovery of iron ore and gas in parts of Western Australia in the 1960s and 1970s, growth in the city accelerated. Progress slowed, with a major stock market crash in 1987 and a related government financial scandal [33]. However, Perth

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[1] Because Noongar is primarily an oral language, there are several spellings of ‘Noongar’ and of Noongar words [31]. Those most commonly used in the source documents consulted will be utilised.

emerged from this and, as the administrative, financial and political hub of Western Australia, continues to grow in size and population as the state's economy booms.

1.3 Research aims and objectives

The aim of the study was to examine the effects of licensed outlets and their alcohol sales on levels of alcohol-related injuries presenting at Perth Metropolitan Emergency Departments (EDs).

1.3.1 Objectives:

a. Identify a validated surrogate measure of alcohol-related injury cases using the Emergency Department Information System (EDIS) for Perth from 2002 to 2010

b. Describe the relationship between place of purchase of liquor and residential location, as well as the influence of price on the distance travelled to purchase liquor using an online population survey.

c. Examine the association between alcohol-related injuries presenting at Perth EDs and numbers of licensed outlets, volumes of alcohol sales and trading hours, accounting for socio-economic and demographic characteristics of residential postcodes.

1.4 Significance

This study includes both counts of alcohol outlets and their sales, making it the first longitudinal study using both measures of alcohol availability. The inclusion of trading hours data, as an additional measure of availability, was a further unique feature of the study.

There is little known about the geographic interfaces between different types of alcohol outlets, volumes of alcohol sales, and alcohol-related injuries which present to EDs. This study aims to bridge this gap by exploring the associations between the physical distance between alcohol outlets and their wholesale purchases, and the areas of residence of those with alcohol-related injuries. The study was strengthened by the collection of primary data about distances commonly travelled by Australians living in capital cities to purchase alcohol. This information was used when constructing buffer zones to model the geographical relationship between alcohol outlets, sales and injuries.

The data used was specific to the Perth Metropolitan Area; thus providing data relevant to the local liquor licence decision-making process. The study was undertaken in conjunction with the Drug and Alcohol Office of Western Australia (DAO) which facilitated access to the data. The DAO: *"...aims to prevent and reduce the adverse impacts of alcohol and other drugs in the Western Australian community"* and to develop and co-ordinate government policies [34]. Because of the partnership with the DAO, the research findings have the potential to impact directly on Western Australian alcohol policy and practice. The findings will also assist the police and EDs plan staffing levels and interventions.

1.5 Overview of the Thesis

The dissertation is organised as follows:

Chapter two presents a brief overview of the history of alcohol consumption and control measures in Australia, specifically relating to the physical availability of alcohol.

Chapter Three reviews the literature relating to alcohol-related injuries in Emergency Departments and the use of surrogate measures of alcohol-related injury. Both international and Australian literature relating to the association between harms and both alcohol outlet density and sales is examined. An overview of other methods of limiting availability is also presented. Literature about methodological issues specific to this study are reviewed.

Chapter Four presents the hypotheses and describes the four phases of the study, including the methodology of each phase, and discusses ethical issues relating to each phase.

Chapter Five presents the results relating to Emergency Department injury data.

Chapter Six presents results of the online survey of alcohol purchasing habits of Australians living in capital cities.

Chapter Seven presents the results of the final models of the relationship between alcohol-related injury and alcohol availability.

Chapter Eight presents the discussion, limitations of the study and recommendations for future research.

2 A brief history of alcohol consumption and control measures in Australia

Australia has a reputation as a nation of drinkers, with a per capita consumption ranking of 30 among 180 countries in 2003 [10]. National per capita pure alcohol consumption estimates have varied from 10.50 litres per person in 1990/91, to 10.40 litres per person in 2006/07, to 10.27 litres per person in 2009/10 [35-37].

In Western Australia, the most recent estimates indicate that per capita consumption of pure alcohol rose from 9.44 litres per person in 1990/91 to 11.69 litres per person and 12.37 litres per person in 2008/9 and 2009/10 respectively[36-39]. This represents an increase of 31% from 1990/01 to 2009/10. In the Perth Metropolitan Area, per capita consumption of pure alcohol was somewhat lower than the state-wide estimates (10.18 litres and 11.55 litres per capita in 2008/09 and 2009/10 respectively).

Alcohol policy has been defined as: "*a set of goals and procedures put in place to regulate the supply of, modify the demand for or reduce the harms associated with alcoholic beverages in a population*" (p. 559 [40]). Bruun et al., in their seminal monograph *"Alcohol Control Policies in Public Health Perspective"*, define alcohol control policies primarily as aiming to limit availability of alcohol [4, 41]. Physical availability can be defined as: "*the likelihood that individuals will come into contact with opportunities to obtain alcohol in their local environment*" (p. 561 [40]). Components of physical availability include outlet density, outlet trading hours, sales to minors and service to intoxicated customers. Physical availability excludes price, which relates to the economic availability or 'affordability' of alcohol to consumers [42]. This study focuses primarily on the impact of the physical availability of alcohol and its relationship with alcohol-related harm in Perth, Australia from 2002 to 2010.

2.1 The early history of alcohol consumption and control policies in Australia

On 26 January 1788, Captain Arthur Phillip, British marines and male convicts gathered around a flagpole and drank a toast to the royal family and the new colony of New South Wales [2]. Thus, from the outset, the colony was linked with alcohol consumption and this pattern continued over the next few decades. For migrants living in a harsh environment far from Britain, drinking represented both entertainment and an escape from the difficult conditions [43]. Rum functioned as a means of payment to convicts and Aboriginal people, and was used to barter for other services [43, 44].

Per capita alcohol consumption was approximately 13 litres per person in the early 1800s [44, 45]. Total alcohol consumption began to drop from the mid-nineteenth century, with beer becoming gradually more popular than spirits. By the 1890s, alcohol consumption had dropped to 5.8 litres per capita, fuelled partly by the availability of alternative forms of entertainment as the country developed, and partly by the increase in the proportion of women and children in Australia [3].

Furthermore, in the late nineteenth century, the temperance movement[2] began to impact on Australian society [44]. With the rise of temperance groups, substantial efforts were made to limit the availability of alcohol [46]. Sunday closing was introduced, firstly in Victoria in 1854, and the minimum drinking age was progressively raised (for example, in South Australia, it rose from 12 years in 1863 to 21 years in 1915) [46].

The introduction of the six o' clock closing time for hotels, in South Australia (1915) and later in New South Wales, Victoria and Tasmania (1916), was the most far-reaching restriction [47][3]. The change from a closing time of 11 o' clock or midnight to 6 o'clock closing led to the 'six o'clock swill'. Instead of decreasing alcohol consumption, the early evening closing time led to large amounts of alcohol being consumed between five and six o'clock [46]. Despite these effects, six o' clock closing remained in force for several decades at hotels across the four states.

2.2 Loosening of alcohol controls

Following the end of the Second World War, sections of Australian society began to object to controls on alcohol availability. A small group of Australian artists and writers who opposed the temperance movement advocated for the removal of restrictions on alcohol by creating a fictitious character, the 'wowser', and using it to influence public opinion on alcohol restrictions. The writer C.J. Dennis defined a wowser as: *"Wowser: an ineffably pious person who mistakes this world for a penitentiary and himself for a warder"* [48]. The wowser was the personification of the forces of uplift and puritanism upheld by the

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[2] The temperance movement was a social movement for the prohibition or reduction of consumption of alcohol (either abstinence or moderation).

[3] It was never introduced in Western Australia, where a 9pm closing time was adopted. In Queensland an 8pm closing time was introduced.

temperance movement and became symbolic of the strong Australian urge to restrict activities of others, including their right to drink and gamble when they wanted to [3].

Changing public sentiment towards alcohol restrictions led to loosening of controls, beginning with the removal of the six o' clock closing time. In Tasmania, closing time was raised to ten o'clock in 1937, by New South Wales in 1954, by Victoria in 1966 and by South Australia in 1967 [46]. Gradually, opening hours were extended, Sunday trading as reintroduced and licence requirements were loosened [46]. Increases in consumption occurred after the Second World War and in the 1960s and early 1970s [44, 46]. Alcohol controls continued to be liberalised in South Australia, Western Australia and Victoria through the 1980s, with earlier opening times and later closing times gradually being introduced. In the Australian Capital Territory a licensee had: *"no trading hours restrictions at all"* and could: *"trade 'all day everyday of the year' as far as the licensing board is concerned"* by the late 1980s (p. 425 [46]).

2.3 Recent developments in regulating the physical availability of alcohol

Since the Second World War, international economic policies have shifted towards less state control and increasing reliance on market forces [40, 49]. Under neoliberalism, alcohol began to be treated as an 'ordinary commodity'. Individual responsibility for safe alcohol consumption was emphasised by Western nations [50]. Despite these policy trends, popular concern increased about alcohol-related problems such as drink-driving or public intoxication at sports and cultural events, [1] and alcohol researchers began advocating for a population-based approach to alcohol misuse [4, 5].

In Australia, each of the eight states and territories have developed liquor control acts and regulations separately, leading to different objectives and approaches to alcohol control [51]. State and territory governments control numbers and types of outlets via liquor licensing authorities (legislated by the liquor control or licensing acts).

From the 1960s, the state of Victoria instituted a series of reviews of the liquor licensing legislation: the 1965 Phillips Royal Commission; the 1977 review of the Liquor Control Act (1968) by J. D. Davies; and the Nieuwenhuysen report on liquor licensing in 1985 [50]. The terms of the latter review were:

"*To Inquire into, review and report on the 1968 act:*

(a) have particular regard to:

(i) The interests of liquor consumers;

(ii) The interests of both existing and potential employers and employees in the liquor and hospitality industries;

(iii) Community attitudes towards the degree of restriction which should be placed upon the sale, distribution and consumption of liquor; and

(iv) The significance of the hospitality and liquor industries in the development of the tourism industries in Victoria" (Vol.1, p. xxv [52])

The Nieuwenhuysen report reflected the international trend towards deregulating the alcohol industry. The author asserted that alcohol-related problems were caused by the minority of drinkers (who were referred to as 'consumers'), contending that availability controls discriminated against the majority of drinkers who drank responsibly [53, 54]and prevented the development of a vibrant night-time economy[50]. He recommended removing many restrictions to alcohol availability, allowing increased numbers of outlets and longer trading hours [53]. Most of his recommendations were adopted by the Victorian government. As a result of these changes, the number of outlets in Victoria increased more quickly than anywhere else in Australia over the next few years [54, 55].

The changes which occurred in Victoria were highly regarded by other states and territories, [54] and stimulated changes to liquor laws across Australia. The revised liquor licensing laws, enacted in the late 1980s, were less liberal than those in Victoria, but reflected a focus on economic growth [30]. For example, the objects of the original version of the Western Australian Liquor Licensing Act of 1988 were explained in Section five as:

(a) to regulate, and to contribute to the proper development of, the liquor, hospitality and related industries in the State;

(b) to cater for the requirements of the tourism industry;

(c) to facilitate the use and development of licensed facilities reflecting the diversity of consumer demand;

(d) to provide adequate controls over, and over the persons directly or indirectly involved in, the sale, disposal and consumption of liquor; and

(e) to provide a flexible system, with as little formality or technicality as may be practicable, for the administration of this Act. [56]

These objects emphasised support for the growth of the liquor and associated industries, and stressed the importance of economic demand by ‘consumers’. Notably, there was no mention of mitigating the negative effects of alcohol on society.

The Federal Government’s support for the liberalisation and deregulation of a range of industries[4] was formalised with the development of the National Competition Policy (NCP) in 1995, as recommended in the Hilmer Report. Under the NCP, alcohol was treated as an ordinary commodity, and was subject to the same rules of competition as any other consumer good. When the National Competition Council (NCC) was formed, states and territories were required to sign agreements to remove legislative restrictions on competition unless retaining a restriction was demonstrated to be in the ‘public interest’. This was to be assessed through a ‘public interest’ test [40, 57].

In the 1990s, state and territory governments began to adopt harm minimisation principles [30]. Amendments to liquor acts in all states and territories broadened the focus of the legislation to target minimising harm from the misuse of alcohol. Tactics to minimise harm

[4] Industries which fell under the NCP included gas, water and electricity supply, retail outlets (including alcohol outlets), roads and rail networks [57].

have been added to the Acts and regulations, including restricting the supply of alcohol and promoting responsible beverage service [30]. With the notable exception of Tasmania, harm minimisation is now explicitly named as an object in all the liquor acts (see Table 2.1 below). Nevertheless, the alcohol industry is still seen as an aid to economic growth (aiming to increase tourism and employment opportunities in the liquor industry), and developing the liquor and associated industries remains a primary objective in most liquor acts. Section five of the current version of the Western Australian Liquor Control Act of 1988[5] illustrates the inclusion of these two potentially conflicting primary objects:

(1) The primary objects of this Act are —

(a) to regulate the sale, supply and consumption of liquor; and

(b) to minimise harm or ill-health caused to people, or any group of people, due to the use of liquor; and

(c) to cater for the requirements of consumers for liquor and related services, with regard to the proper development of the liquor industry, the tourism industry and other hospitality industries in the State.

(2) In carrying out its functions under this Act, the licensing authority shall have regard to the primary objects of this Act and also to the following secondary objects —

(a) to facilitate the use and development of licensed facilities, including their use and development for the performance of live original music, reflecting the diversity of the requirements of consumers in the State; and

[(b), (c) deleted]

(d) to provide adequate controls over, and over the persons directly or indirectly involved in, the sale, disposal and consumption of liquor; and

(e) to provide a flexible system, with as little formality or technicality as may be practicable, for the administration of this Act (p. 15[58]).

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[5] Originally known as the Liquor Licensing Act of 1988.

Despite the objects of the state and territory acts, there are no explicit restrictions on outlet density. However, restrictions on hours of sales (and provision for applying for extended trading permits) are present in all eight acts (Table 2.1).

In the Central Business Districts (CBDs) of certain major cities and in some rural rural and remote communities across different states and territories, mandatory restrictions restrictions and alcohol-free zones have been enforced [55]. Community-initiated interventions have also been implemented in individual Indigenous communities in the Northern Territory, Western Australia and Queensland. With the support of the communities, the Liquor Commission amended licences to restrict days and hours of sale, types and volumes of beverages and venue requirements in Tennant Creek, Northern Territory. Alcohol availability restrictions were imposed on outlets, including banning the sales of wine in casks greater than two litres and limiting days and hours of sales (for example on paydays or days when social benefits were paid) [59]. Evaluations of these changes indicated a 19% decrease in drinking levels over a two year period, with accompanying decreases in arrests and hospital admissions [60, 61]. Other community-based restrictions have been implemented in Indigenous communities. For example, a supply-reduction strategy was implemented in remote Queensland communities. Analyses of longitudinal injury data found that these restrictions had effectively reduced serious alcohol-related injuries in the Queensland communities [62].

Table 2.1: An overview of the current liquor licensing legislation in the states and territories in Australia

Jurisdiction	**Directly related acts and regulations**	**Agency responsible for administration and review of applications**	**Major objectives**	**Liquor act and regulations relating to trading hours and outlet restrictions**
New South Wales	Liquor Act 2007 Liquor Regulations 2008	Office of Liquor, Gaming and Racing Casino, Liquor and Gaming Control Authority	-Regulate sale and consumption of alcohol according to community expectations and needs -Facilitate balanced development, in the public interest of the liquor industry, and related industries -Minimise alcohol-related harm and promote responsible attitudes to sale and consumption	-Liquor licensing 'Freeze' for licence granting and extended trading hours permits for parts of the Sydney LGA from 10 October 2009 to 24 December 2012 depending on the area -'Hassle Free Nights' to five entertainment areas with increased enforcement and powers to reduce trading hours. Aimed at reducing assaults. -Local liquor accords -Additional licensing conditions on outlets with high number of violent incidents -Six hour closure (4am to 10am) of outlets -Lockouts
Victoria	Liquor Control Reform Act 1998 Liquor Control Reform (Prescribed Class of Premises) Regulations 2008 Liquor Control Reform (Prohibited Supply) Regulations 2005 Liquor Control Reform Regulations 2009	Responsible Alcohol Victoria Victoria Civil and Administrative Tribunal	-Minimise harms from alcohol misuse by adequately controlling supply of alcohol, encouraging responsible consumption and reducing risky drinking -Facilitate responsible development of the liquor industry -Regulate licensed adult entertainment premises	-Individual licence or permit specifies allowed trading hours -Risk-based licence fees (higher fees for outlets with increased risk of alcohol-related harm) -Petrol stations, drive in cinemas, milk bars/convenience stores and premises to be primarily used by those under 18 years are prohibited from selling alcohol -Local liquor accords -Lockouts
South Australia	Liquor Licensing Act 1997 Liquor Licensing (General) Regulations 2012	Office of the Liquor and Gambling Commissioner Licensing Court	-To encourage responsible attitudes towards sale, promotion and use of alcohol, and minimise harm associated with consumption -To further the interests of the liquor industry, within the context of the act and regulations -Ensure that liquor contributes to and does not detract from the amenity of community - To enhance competition among liquor suppliers	- Trading hours defined. Extended trading hours allowed if this will not result in disruption of the community around the outlet and will implement policies to prevent harmful use of alcohol -Local liquor accords -Lockouts

Jurisdiction	Directly related acts and regulations	Body responsible for administration and review of applications	Major objectives	Liquor act and regulations relating to trading hours and outlet restrictions
Queensland	Liquor Act 1992 Liquor Regulations 2002	Office of Liquor, Gaming and Racing. Queensland Civil and Administrative Tribunal	-Regulate the liquor industry so as to minimise harm caused by alcohol misuse (primary objective) -Facilitate the development of the liquor and associated industries, while regarding the needs of the community and economic implications -Regulate the provision of adult entertainment	-Trading hours legislated and extended hours trading permits could be applied for -Moratorium on application for ETPs from October 2009 to 2013(some areas excluded) -Hotel licences extended to a maximum of two detached bottle shops within 10km of hotel -Supermarkets may not be granted a liquor licence -Risk-based licence fees (higher for outlets with increased risk of alcohol-related harm) -Local liquor accords -Lockouts
Western Australia	Liquor Control Act 1988 Liquor Commission Rules 2007 Liquor Control Regulations 1989i	Director General: Department of Racing, Gaming and Liquor: Liquor Licensing Division Liquor Commission	-Regulate the supply, sale and consumption of alcohol -Minimise harm and ill-health due to alcohol use -Development of liquor and related industries, according to the needs of consumers	-Extended trading permits which varied trading hours could be granted at the discretion of the Licensing Authority. -Licensees must maintain a register of unruly behaviour, evicted patrons and complaints by neighbours -Local liquor accords -Lockouts
Tasmania	Liquor Licensing Act 1990 Liquor Licensing Regulations 2003	Liquor and Gaming Branch, Revenue, Gaming and Licensing Division Commissioner for Licensing Board.	-Not stated in the Act -“to regulate the supply of liquor” (from the title of the Act)	-Provision for out-of-hours permit for trading between midnight and 5am -Supermarkets may not be granted a liquor licence

Jurisdiction	Directly related acts and regulations	Body responsible for administration and review of applications	Major objectives	Liquor act and regulations relating to trading hours and outlet restrictions
Northern Territory	Liquor Act Northern Territory Licensing Commission Act Northern Territory National Emergency Response Act 2007 Liquor Regulations	Director, Licensing, Regulation and Alcohol Strategy Division Licensing Commission	-Minimise harm from alcohol misuse -Take into account public interest with regard to sale, promotion and consumption of liquor -Protect and enhance community amenity through sale and consumption of liquor -Responsible development of liquor and associated industries in NT	-The Liquor Act does not specify trading hours. Restrictions on times and days of opening (i.e. trading hours) when licence is granted - Licence may be granted if it is in the public interest) -Public restricted areas, public restricted premises, general restricted areas and special restricted areas to prevent selling or consuming of alcohol without a permit. Also Commonwealth restricted areas (Northern Territory National Emergency Response Act) -Local liquor accords -Lockouts
Australian Capital Territory	Liquor Act 2010 Liquor Regulations 2010	Commissioner for Fair Trading, Office of Regulatory Services ACT Civil and Administrative Tribunal	-Harm minimisation -Responsible development of liquor industry -Encourages consumers to be responsible for consumption and actions	-Prescribed trading hours (including extended trading hours) were described in the Liquor Regulations 2010. -Risk assessment management plans required when applying -Must keep a register of anti-social or violent incidents which occur at premises -Licensee may not sell petrol to someone at the premise -Risk-based licence fees (higher fees for outlets with increased risk of alcohol-related harm) -Permanent alcohol-free zones named in regulations -Lockouts

(Sources: [49, 56, 58, 63-78])

The National Competition Commission (NCC) scrutinised three aspects of altered liquor licensing legislation: impact on competition, trading hours, and number of outlets. The NCC required various changes to individual acts where the requirements of the acts were judged to be 'anti-competitive' [49]. Consequently, state and territory alcohol availability has been influenced by the requirements of the federally controlled National Competition Policy (NCP). The federal government pays annual incentives to the states and territories for complying with the requirements of the NCP. In 2004/5 and 2005/6, the NCC ruled that several jurisdictions (Western Australia, Queensland, Northern Territory and South Australia) had failed to address anti-competitive aspects of legislation and their payments were reduced by 5% [49]. As Trifonoff and colleagues comment in their recent comprehensive review on liquor control legislation in Australia:

"…tensions can exist between the national push to free-up competitive forces and the state/territory desire to reduce alcohol supply, or at least shape it in ways that are least harmful. There is also a strong financial incentive for jurisdictions to comply with the National Competition Policy to amend liquor licensing legislation and reduce competitive forces in the alcohol industry" (p. 5 [49]).

The NCP aims to remove anti-competitive restrictions that are not in the public's best interests. It considers that a 'public needs' or 'proof-of-need' test restricts competition as it: *"requires applicants for new licences to demonstrate that a particular area is not already adequately served by existing outlets. In effect, the test operates to protect existing outlets from new entrants"* (p. 21.6 [57]). Blanket restrictions excluding all supermarket chains from acquiring licences are also regarded in anti-competitive. The NCP does, however, support 'public benefit' testing of licence applications; that is, focusing on the social, community and health implications of granting a liquor licence [79, 80] and it is now mandatory to undertake a public interest test when applying for a liquor licence in Australia (e.g. in Western Australia [81]. As the NCC states:

"Licensing tests that focus on the public interest via non-discriminatory provisions aimed at harm minimisation and community amenity, without references to outlet density or competitive effects on incumbents, are unlikely to contravene NCP principles and should provide considerable freedom to address social concerns" (p. xix [82].

Acceptable licensing restrictions, which aim to minimise harm without violating anti-competitive principles, include: restrictions on legal drinking age, restrictions on service to intoxicated persons, non-discriminatory trading hours, and tax and excise on alcoholic beverages [80, 83]. However, the onus has been on the state and territory governments to demonstrate how restrictions to trading hours, for example, are in the public interest. Restrictions are permitted if a 'social impact assessment' (not a 'public needs' test) indicates their benefit [80]. In some states, the numbers of liquor outlets have increased rapidly in recent years as a result of these policies [40, 84].

Given the often conflicting goals and interests of federal and state/territory governments, the third tier of government, local councils, face many challenges in the management of alcohol. Local councils lack the necessary legislative powers to make licensing decisions. They are responsible for town planning but are required to enforce licensing decisions made at state- and territory-level. The National Local Government Drug and Alcohol Advisory Committee, in its submission to Ministerial Council on Drug Strategy in 2008, expressed these difficulties as follows:

"Local governments and individual communities can play a valuable role in implementing alcohol legislation in locally applicable ways to reduce alcohol-related harms [51]. Local government powers under these legislations are often ambiguous and disconnect planning, building, health, crime prevention and licensing decisions.

Local government is not sufficiently recognised or empowered to set planning controls to balance alcohol industry needs with community health and safety.

The lack of regulation and enforcement of licenses across all jurisdictions is a key contributing factor to alcohol harms in the community" (p. 2[51]).

Voluntary Community Liquor Accords are community level interventions led by the police and sometimes the local council. These community interventions are popular but non-binding agreements involving local licensees, other businesses and community representatives. The interventions include responsible beverage service, reduced price discounting and 'happy hours', and routinely conducted age-checks of patrons [54]. However, while these voluntary agreements may foster improved communication and relations among participants, several rigorous evaluations have concluded that they do not significantly reduce alcohol-related problems [85].

The National Local Government Drug and Alcohol Advisory Committee argue that local government should have the power to make binding decisions, for example to decide on trading hours and outlet density, and greater powers to appeal against loss of amenity by local communities [51].

2.4 The way forward

The limitations imposed by the NCP on licensing controls present a major obstacle to developing an effective and coherent Australian alcohol policy. The difficulty integrating the different priorities of the three tiers of government regarding alcohol represents a further challenge to policy-makers [10].

The alcohol industry is an additional barrier to policy development [10, 86]. Doran et al. argue that: "*governments have a conflict of interest in alcohol policy because the alcohol industry provides much (taxation) revenue for both state and federal governments*" (p. 469 [86]). Industry groups have lobbied against efforts to implement policies which aim to reduce harm by decreasing alcohol consumption, instead pushing for 'self-regulation' as a guiding principle for alcohol policy [86].

The National Preventative Health Taskforce named the five imperatives for further developing Australian alcohol policy:

1. *"Reshape consumer demand towards safer drinking…*
2. *Reshape supply through lower-risk products…*
3. *Strengthen, skill and support primary health care to help people in making healthy choices*
4. *Close the gap for disadvantaged communities*
5. *Improve the evaluation of interventions…"* (p. 43 [10]).

The first imperative can be accomplished by controlling the availability of alcohol: physical availability through outlet density and trading hours, and economic availability through taxation and pricing [10]. In response to the findings by the National Preventative Health Taskforce, the Australian National Preventive Health Agency was established in January 2011 with the aim of: *"developing policies and programs that address the harmful consumption of alcohol and strengthen design, implementation and evaluation capacity"* [87].

This thesis will review the evidence about the relationship between the physical (and economic) availability of alcohol and alcohol-related harm (Chapter three). The thesis will then explore the associations between measures of availability (counts of outlets, alcohol sales and trading hours) and alcohol-related harm in Perth, Australia (Chapter five onwards).

3 Literature review

This chapter undertakes a review of the literature related to the study. The chapter begins with an overview of the literature on alcohol-related presentations at hospital Emergency Departments (EDs), focusing specifically on alcohol-related injuries. This is followed by a discussion of methods used to assess alcohol-involvement in cases presenting at EDs. The next section discusses availability theory and other theoretical frameworks used to explain the relationship between alcohol availability and harms. Aspects of availability that are pertinent to the study are briefly reviewed. This is followed by a detailed review of alcohol outlet density and sales literature, including the evidence for the association of these measures of availability with alcohol consumption and harms. Finally, specific methodological issues with a bearing on this study are discussed.

3.1 Search strategy

The literature discussed in this review has been divided into two major components: ED literature and alcohol availability literature. During the search for ED literature, several major reviews were identified which analysed relevant studies from the mid-1980s onwards. The reviewed articles were then followed up. Those articles which cited the reviews were also sourced. Further articles were identified using the following scholarly databases: Scopus, ScienceDirect, Ovid, Medline, and ProQuest. Various keywords were used for the search, including “injury”, “alcohol”, “Emergency Department”, “Emergency Room”, “Accident and Emergency”, “surrogate measure” and “BAC” (Blood Alcohol Concentration). Major reports by the World Health Organization (WHO) were also identified from its website. The search for Australian-based literature was particularly rigorous and included ‘grey’ literature published by government agencies and research units.

Further literature was sourced by searching for major papers, monographs and book chapters that have sought to explain the relationship between alcohol availability and harms. Scholarly databases, as well as the Google and Google Scholar search engines, were then used to explore the background to the relevant theories. The search for literature relating to alcohol outlet density and alcohol sales was exhaustive, with articles published between 1970 and 2013 identified. Frequently cited articles between 1970 and 1993 were reviewed, and all identified articles published between 1994 and May 2013 were reviewed. Methods used to identify the articles included using citations from important articles and sourcing articles that cited these articles (by means of citation alerts), and searching Google, Google Scholar and the major scholarly databases identified above. Keywords used in the search included “alcohol outlet density”, “alcohol sales”, “alcohol availability”, “alcohol-related harms”, “buffer zones”, and “alcohol consumption”. The alcohol outlet research area is well developed, and certain groups of researchers have investigated alcohol outlet density for many years. Some of these authors were specifically searched for by name, for example, “Paul Gruenewald”, “Andrew Treno”, “Bridget Freisthler”, and “Richard Scribner”. The National Drug Research Institute’s (NDRI) comprehensive internal library was also searched, particularly for relevant reports, monographs and book chapters.

3.2 Alcohol and injury

Alcohol use contributes significantly to the global burden of disease [88]. Consumption of alcohol has been associated with risk of cancers (oral, oesophageal, colorectal, liver, laryngeal and breast); hypertension; cerebrovascular disease; gastric and duodenal ulcers; liver cirrhosis and other chronic liver diseases; and pancreatitis [89]. Short-term risks of alcohol use include injury, which accounted for more than 850,000 deaths globally in 2002 [90]. Internationally, burden of disease studies have estimated that 28% of alcohol-attributable Disability Adjusted Life Years (DALYs) result from unintentional injuries[6], with 12% more accounted for by intentional injuries[7] [92].

The short-term physiological effects of alcohol include decreased motor coordination and balance, impaired attention, perception and judgement [91]. These impairments may help to explain the association between alcohol use and injury [93, 94], particularly injury due to personal violence [90, 95]. Previous research has demonstrated that the amount of alcohol consumed on a single occasion is a more important risk factor for injuries resulting from violence than ‘usual drinking’ (average consumption) [96, 97]. Even at low and moderate levels of consumption (less than five drinks for men or less than four drinks for women), injuries are more likely to be alcohol-related[8] than attributable to other causes [98]. Previous research suggests that heavy drinkers [99] and those with alcohol dependence [100] may be at lower risk of injury than those who drink less frequently.

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[6] Intentional injuries include violent incidents such as suicide and assault.
[7] Non-intentional injuries include road crashes involving motor vehicles, bicycles and pedestrians, work-related trauma, drowning, fires and falls [91].
[8] Injuries are more likely to be alcohol-related due to the high prevalence of interpersonal violence causing injuries when alcohol is involved [98].

The definition of injury continues to be the subject of debate [101]. The WHO defines injury as "…*caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance. In some cases (for example, drowning and frostbite), injuries result from the sudden lack of essential agents such as oxygen or heat*" (p. 4 [102, 103]). This definition includes injury resulting from excess exposure to energy, leading to *"relatively sudden, discernible effects"* (p. 8 [104]), and excludes conditions resulting from continual stress, for example carpal tunnel syndrome [105]. Most definitions of injury exclude complications from medical treatment [101]. Acute poisoning is regarded as exposure to chemical agents, so may be considered an injury [102]. Therefore, poisoning by alcohol and drugs is included in any definition of injury [106]. Robertson, in his seminal text on injury epidemiology, suggests that each study should specifically define inclusions and exclusions of what is classified as an injury [104].

3.3 Alcohol-related presentations at the ED

EDs are unique sources of research data, as they capture both alcohol-related cases that are serious enough to be admitted to hospital and less serious alcohol-related cases not requiring admission to a hospital ward. They also provide medical data not available from police reports [25].

As serious injury is a relatively rare event in the general population, EDs provide an excellent opportunity to study the role that alcohol plays in injury cases [25]. Most moderately to severely injured people who live in urban areas will present at an ED. Even those without the resources to afford private health care usually have access to treatment at a public hospital ED [90]. Assault victims are more likely to seek medical than police assistance. ED records, therefore, include more assault cases than police records and also better represent the incidence of violence at licensed premises [107].

Prior to 1984, few sound epidemiological studies had been undertaken in EDs [90]. Studies in the last 30 years have focused on assessing and measuring the presence of alcohol in injury cases; establishing the link between alcohol consumption and injury; demonstrating causality, particularly in terms of a dose-response effect and injury severity; and demonstrating the effects of alcohol on injury in different population subgroups [24, 25, 108, 109].

Prevalence studies dominated the ED literature prior to the mid-1990s [24, 108]. These studies lacked a control group, and were unable to demonstrate causality. Thus, the risk of injury after exposure to alcohol could not be calculated [109]. Since that time, ED-focused studies investigating the association between alcohol and injury have more frequently used case-control studies and case-crossover designs (a variation on case-control studies).

The case-control design has frequently been used to explore the association between alcohol and ED injury presentations [96, 97, 100]. A major difficulty with this design is the choice of controls. Hospital controls (frequently non-injured ED patients) have alcohol consumption patterns that are more similar to those of injured ED patients than to those in the general population [110]. Cherpitel argues that all ED patients (both injured and non-injured) are more likely to use alcohol, in higher quantities, have more alcohol-related problems than the general population [24], and may even present at the ED for an alcohol-related condition that is not an injury [109]. Thus, the usefulness of hospital controls in ED studies is questionable. Case-control studies with general population controls are less prone to bias because the controls' drinking patterns are more representative of the general population and are less prone to recall bias than hospital controls [111]. Studies with general population controls are, however, considerably more expensive and complex to undertake.

Other ED studies have used a variation of the case-control study, the case-crossover design [93, 100, 112-115], while some research has combined the case-control and crossover designs [97, 116]. The case-crossover methodology overcomes the difficulties of choosing an external control. Each case becomes its own matched control by asking the person interviewed to recall his or her alcohol consumption at the same time of day either the day before or the week before the injury. However, the crossover design does have limitations. Usual patterns of drinking among individual participants may bias results: case-crossover pairs who either drink or abstain at both the 'case' and the 'control' recall times are effectively ignored in the analysis. Furthermore, cases are more likely to recall alcohol consumed immediately prior to the injury than in the earlier 'control' time period (that is, recall bias is greater in the 'control' period). Altered associations between alcohol and injury may result because of both usual drinking patterns and recall bias [90, 109].

3.3.1 International studies

A review of international ED studies up to 1993, which investigated the association between injury and alcohol, found that most well executed studies had been undertaken in developed countries, primarily in the USA [24]. The review concluded that the role played by alcohol in injury varied from place to place and depended on the socio-demographic characteristics of the population studied. Patients presenting with an alcohol-related injury were more likely to be male, between 25 and 45 years old, and to present at EDs on weekend evenings or in the early hours of the morning [24]. Among the studies that used probability sampling[9] of ED cases, between 6% (suburban California, USA) and 34% (US army hospital in Germany) of injured patients had positive BACs; between 8% (suburban California, USA) and 35% (San Francisco, USA) of those injured reported consuming alcohol in the six hours prior to the injury event. Prevalence estimates were difficult to compare across and within countries because of differing sampling methods and populations. Cherpitel emphasised the importance of using probability sampling of patients as this enabled more accurate estimation of the prevalence of alcohol-involvement in injuries. The review also discussed using case-control studies to determine the risk of injury after consuming alcohol, as well as the above-mentioned difficulties of finding a suitable control group. The author did, however, describe a small number of studies where these difficulties had been overcome and which indicated that the risk of injury increased with increasing BAC [117, 118].

In a further review published the following year, Cherpitel [108] specifically reviewed ED-focused studies of injuries resulting from violence, concluding that alcohol was involved in a high proportion of these injuries. The estimated prevalence of alcohol-involvement in injuries resulting from violence varied widely across the studies examined, ranging from 17% of the patients concerned displaying positive BACs (suburban California) to 64% of patients displaying positive BACs (EDs in urban France). The author concluded that the range of findings was the result of differing age criteria, lengths of time for data collection and proportions of cases for which BACs were collected. Results also differed across regions and countries, although the research and sampling methods were similar across the studies. These differences were probably the consequence of varying patterns of drinking and drinking cultures among countries. Because probability sampling was not used in all studies, studies which sampled primarily over weekends or evening (when most drinking occurs) would find higher prevalence of alcohol involvement in injuries. Cherpitel noted that a major limitation of these studies was the lack of data on the recent alcohol consumption of the perpetrator of the violence that caused the injury.

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[9] Probability sampling means that every case has a chance of being selected. The sample should therefore be representative of the population served by the ED. The results can be used to make accurate estimates of population measures.

Since 2000, most ED-focused research into alcohol and injuries has been the result of collaborations among researchers using similar methodologies, in different countries and regions of the world. Two main collaborations have been formed: the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP) and the WHO Collaborative Study on Alcohol and Injuries (WHO-ER). ERCAAP has produced cross-national meta-analyses of alcohol and injury [119-121], as has the WHO-ER [113]. Analyses have been performed using data from both collaborations [99, 122-126].The collaborations have indicated alcohol-involvement from 24% (positive BAC) up to 29% (self-reported alcohol consumption) of injury cases across 16 countries [122]. The authors estimated a 5.60 (95% confidence interval (CI) = 4.04–8.00) pooled relative risk of injury for self-reported alcohol consumption across these countries [99].

A later international review revealed that, between 1995 and 2005, ED-focused studies in this field were undertaken across a wider range of developed countries and in several developing countries [25]. The review indicated positive BACs ranging from 4% (Ontario, Canada) to 59% (South Africa) among injured patients presenting at EDs. A similar range was displayed for self-reported alcohol use in the six hours preceding ED presentation with an injury (between 8% in Warsaw, Poland, and 60% in South Africa). The prevalence of alcohol consumption prior to violent injury was even higher, rising to 70% in South Africa for positive BACs and 84% in Canada for self-reported consumption [25].

A recent systematic review and meta-analysis of self-reported alcohol consumption and injury specifically has investigated ED-focused alcohol and injury studies using case-control and case-crossover designs [111]. The review included studies published between 1970 and 2009. The overall odds of injury for those who had consumed alcohol, calculated from ED case-crossover studies, were 3.82 (95% CI: 2.65–5.50); calculated from ED case-control studies, the odds of injury among drinkers (compared to non-drinkers) were 1.98 (95% CI: 1.39–2.82). The odds of injury among drinkers, calculated from case-control studies, were slightly less than those for the case-crossover method (Odds Ratio/OR: 3.15; 95% CI: 1.58–6.25) and the authors consider these to be the best estimate of the risk of injury after alcohol consumption. Zeisser has concluded that the nature of the study design and the potential for recall bias tend to result in case-crossover studies overestimating the effect of alcohol on the risk of injury, while case-control studies using hospital controls underestimate this association.

Causal relationship between alcohol and injuries

Studies done in EDs have investigated the causal relationship between alcohol and injury [95, 127]. The demonstrated criteria for causality are the temporal sequence of events, the strength of associations, biological plausibility, and the consistency of findings. Several ED-focused studies have shown a dose-response relationship between levels of alcohol consumption and the risk of injury [89, 90, 98, 113, 124, 128]. Degrees of risk vary according to the cause of injury, e.g. road trauma, burns, accidental poisonings or intentional violence [129]. Alcohol-impaired patients have an elevated risk of unintentional injury [113], and are more likely be injured as a result of violence than from any other cause [125].

Injury severity and alcohol

Injury severity is classified by clinical signs and symptoms (such as level of consciousness, respiratory rate, blood pressure, heart rate, anatomical location of and number of regions injured), which are combined to derive injury severity scores such as the Abbreviated Injury Scale (AIS), the Injury Severity Score (ISS), the ICD-derived Injury Severity Score (ICISS), the New Injury Severity Score (NISS) and the Revised Trauma Score (including the Glasgow Coma Score) [104, 130]. These scores provide an indication of threat to life, length of treatment required and disability level, and each has its advantages and disadvantages [104]. The terms mild, moderate and severe injury are defined differently by each severity score. Broadly, a mild injury would not require admission to hospital, while a more severe injury would require admission to hospital and could be life-threatening [131].

Previous studies comparing the severity of alcohol-related injuries to that of non-alcohol-related injuries have produced mixed results [25, 90, 108, 132-135]. The differences in results among such studies can be partly explained by the different methods used to define the severity of an injury. For example, in one study an injury was considered ‘more severe’ if it resulted in hospitalisation [131], while score-based measures of severity were used in other studies, for example, in the Glasgow Coma Score [136]. Kuendig et al. have suggested that the conflicting results in alcohol/injury severity studies may be because severity scores for injuries to different regions of the body are pooled to derive some measures of severity, potentially confounding the association between alcohol and severity [98]. Methods of assessing head injury cases can lead to greater injury severity scores in alcohol-affected cases; intoxication leads to inflated Glasgow Coma Scores (for example [136, 137]).

At a physiological level, alcohol has been shown to adversely influence the severity and outcome of injury [138]. Results from studies conducted in EDs or using police reports have indicated that injuries associated with alcohol use can be more severe than non-alcohol-related injuries [125, 139]. This may be mediated by the risky behaviour (such as speeding while driving or higher levels of aggression) that accompanies alcohol consumption rather than the biological effects of alcohol [138 386]. Alcohol-related violent encounters may be prolonged because of the loss of inhibition among the participants. Moreover, alcohol-impaired victims may be less able to protect themselves because of slower response times and decreased coordination. These factors could contribute to more severe injuries [133].

Further, more severely injured patients are likely to arrive at EDs sooner than less severely hurt patients. BAC measurements in the more severely injured may therefore be higher because a shorter time has elapsed between injury and presentation at the ED [24]. This could lead to the incorrect assumption that the severity of the injury is related to the presence of alcohol [24]. Studies of hospitalised patients have demonstrated an association between alcohol and injury severity, but these studies exclude patients with very severe injuries (who do not survive) and mild injuries (who are not admitted).

It is thus very difficult to control for confounding factors which ‘increase’ injury severity, or assess the influence of case selection on the link between injury severity and alcohol intake. Further research is necessary to investigate whether alcohol-involvement is associated with more severe injuries.

3.3.2 Australian studies

Several studies have been conducted in Australian EDs including prevalence studies [140, 141], case-control studies [142-144] and a case-crossover study [115]. The estimated prevalence of alcohol-involvement (using self-reported alcohol consumption in the six hours prior to injury) has ranged from 22% [142] to 34% [140, 144] of injured ED patients.

An Australian case-control study, based in Fremantle, Western Australia (WA), and using matched community controls, demonstrated an increased risk of injury at high levels of alcohol consumption [142, 143]. Specifically, the study suggested that, at all consumption levels, women were at higher risk of injury than men. Women who consumed more than 90 g of alcohol were most at risk of injury (OR =9.60; 95% CI: 2.05–44.23). However, the confidence intervals at all levels of consumption were wide, possibly due to the small sample size at each drinking level.

Further analysis, which accounted for drinking settings and activity, confirmed a clear dose-response effect, particularly among female drinkers. However, interpretation of the results was again hampered by small sample sizes at each consumption level [143].

A further case-control study, based in the Gold Coast region of Queensland, investigated alcohol-related injuries in EDs using matched community controls [144]. The analyses included the effects of beverage preference and measures of risk-perception and risk-enjoyment on injury risk. Analyses of the data showed that drinking above the recommended Australian low-risk drinking guidelines increased injury risk by 2.5 compared to those who did not drink within six hours of injury. The results suggested that both sensation-seeking and high risk-perception[10] of drinking were associated with reduced risk of injury. The authors concluded that the increased risk of injury after consuming some beverage types was explained by demographic and other personal characteristics of drinkers (such as risk-taking behaviour) rather than beverage-specific properties. Further analyses suggested that those who drank beer or spirits above the minimum drinking guidelines were more at risk of a more severe injury, rather than a minor or moderate injury[11] [130].

A prevalence study was undertaken in a large inner city ED (in a busy entertainment district) in Sydney [140]. The study assessed the prevalence of alcohol-involvement in injury presentations to the ED. It specifically assessed the contribution of alcohol to violent injuries. Thirty-four per cent of injured patients reported drinking alcohol during the six hours prior to the injury. Of this group, 60% presented at the ED between 6 pm on Friday night and 6 am on Monday morning. A higher proportion of assault patients reported consuming alcohol compared to patients with injuries from non-violent causes (65% compared to 29%).

A case-crossover study, undertaken at six EDs in Sydney, revealed a significantly increased risk of injury under the following circumstances: at very high alcohol consumption levels (>90g: OR=1.86, 95% CI: 1.48–2.20); when drinking alone (OR=1.36, 95% CI: 1.04–1.77) ; and when drinking in a group of more than two people (OR=1.49, 95% CI: 1.26–1.76) [115].

The study estimated that only 17% of injured cases reported using alcohol in the six hours preceding ED presentation—a much lower prevalence estimate than other Australian

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[10] High risk-perception is the perception that risk associated with an activity was great.
[11] Injury severity was defined by the New Injury Severity Score as Minor (NISS 1–3), Moderate (NISS 4–8) and Serious (NISS = 9) [130].

studies. The authors suggest this could be explained by the population served by these EDs, which included a high proportion of people who do not speak English at home and come from cultural backgrounds where regular alcohol use is uncommon (which could result in lower prevalence of alcohol consumption in the total population or in social desirability bias) [115].

Havard et al. [141] undertook a prevalence study of alcohol-related presentations at four EDs in rural New South Wales (NSW). This study examined all ED presentations, estimating that 9% of all ED presentations were alcohol-related. Nineteen per cent of these alcohol-related presentations were injuries, of which almost 36% were alcohol-related. This level of prevalence is similar to the estimates by Watt [144] and Poynton [140].

In summary, multiple studies have been undertaken to assess the role of alcohol in injuries presenting at EDs, particularly assigning causality, and to assess the prevalence of alcohol-involvement in the ED. However, varying methods make comparisons between the studies challenging.

3.4 Measuring alcohol-involvement in patients presenting at EDs

Various methods, each with its own strengths and weaknesses, have been employed to assess alcohol-involvement in ED injury presentations, including self-reported alcohol consumption in the six hours prior to the injury; BAC; triage notes; diagnostic codes (e.g. International Classification of Diseases, Tenth Revision or ICD-10 codes); clinical suspicion[12]; and surrogate measures of alcohol-involvement.

3.4.1 BAC

BAC is a biological marker that establishes the level of intoxication at the time of testing. It is not routinely recorded in most EDs. While universal testing of BAC would be ideal, funding and time constraints prevent this. Moreover, in certain countries routine blood testing may breach civil rights or privacy legislation [90, 145]. A study using trauma registry data consisting of 17,356 cases (BAC was measured in 65% of these cases) established that cases with the following characteristics are more likely to be tested: the injury occurred on Saturday or Sunday; the injury involved violence, a single motor vehicle, being a pedestrian, or

[12] Clinical suspicion is the clinician's subjective assessment of alcohol-involvement in a case.

suicide; the injured person was male; aged 21 to 34; suffered skull fractures and intracranial injuries. However, these groups are also more likely to have positive BACs than other ED presentations [146, 147].

As an objective measure of alcohol consumption, BAC is a useful marker of alcohol-involvement for the researcher. However, one of the difficulties with using BAC in research studies is that the blood alcohol level depends on several factors, including the amount of alcohol consumed (number of drinks and strength thereof); the time that has elapsed between the injury occurring and the blood sample being taken, and the patient's age, gender, body type and weight. For example, if several hours have passed between the time of the last drink and arrival at the ED following an injury, the BAC may have dropped to zero by the time it is measured at the ED. More severe cases may arrive at EDs sooner and receive attention faster than less severe cases, leading to more severe cases recording higher BACs than less severe cases [24]. Alternatively, the patient may have consumed alcohol *since* the injury and the injury could be incorrectly linked to this consumption [90]. Practical barriers to using BAC in research include the cost and the technical expertise required to take a blood sample [90].

3.4.2 Self-reported alcohol consumption in the six hours prior to injury

Self-reported drinking in the six hours prior to the injury is another method used extensively in ED studies to assess alcohol consumption [24, 25]. Unlike BACs, self-reports of consumption demonstrate the temporal relationship between drinking and injury, that is, that drinking precedes injury [91]. Previous research has often employed both investigator-administered BAC testing and patient self-reported consumption to establish the reliability of the latter [100, 119, 122].

An international ED-focused study compared self-reported alcohol consumption with BAC measurements [148]. The study revealed that a relatively small proportion of patients with positive BACs denied drinking within the six hours prior to injury [148]. These patients may have consumed alcohol after the injury but before presenting at the ED [149]. A higher proportion of patients with negative BACs reported drinking in the six hours prior their injuries. The negative BAC measurements may be explained by the lapse of several hours between drinking and BAC testing (resulting in the alcohol not being detectable at the time of measurement) [149]. A further study using BAC as a baseline measure of alcohol-involvement in injury also reported the high sensitivity and specificity of self-reported alcohol consumption [150].

Correlating levels of reported alcohol use with measured BAC has proved to be more difficult. Studies by Sommers and colleagues demonstrated that self-reporting of alcohol consumption tends to underestimate the volume of consumption, suggesting a lower BAC than is in fact the case [151, 152]. This differential between self-reported consumption and actual measured BAC was greater among female respondents. The research suggested that, while drinkers were prepared to acknowledge alcohol consumption, they tended to under-report the volume consumed [151]. A more recent study has found that a strong relationship exists between BAC and self-reported drinking of up to seven drinks. Beyond this level of consumption, the correlation disappeared [149].

Self-reported alcohol consumption can be a more sensitive measure of alcohol consumption than BAC as it is not affected by the time which has passed from the time of injury to the time of ED presentation [90]. However, collecting accurate self-reported data is time-intensive and costly. Therefore, self-reported alcohol consumption is not necessarily a practical measure of alcohol-involvement in injury cases [90].

3.4.3 Triage notes

Australian research has explored the use of triage text to identify alcohol-involved injury cases [153, 154]. A review of three years of presentations at two inner city EDs in Sydney used both nursing triage text and ICD-9 diagnostic codes to identify alcohol- and other drug-linked presentations. Of the 14,104 ED presentations flagged as alcohol-related from the triage text (5.3% of 263,937 ED presentations), 90% contained mentions of alcohol in both the triage text and the ICD-9 coding [154]. A sub-analysis of one ED found that 76% (4,080) of 5,358 identified alcohol-related ED presentations could be identified using nursing triage text [153]. This represented only 3.4% of the total ED presentations (118,881) [153]. Considering such a small proportion of ED cases was classified as alcohol-related compared to other studies (for example, 9% of all ED presentations estimated by Cherpitel [155]), the authors concluded that the use of nursing triage text leads to underestimates of the prevalence of alcohol-involvement in ED presentations.

3.4.4 Diagnostic codes

The International Classification of Diseases (ICD) is "*the standard diagnostic tool for epidemiology, health management and clinical purposes*" [156].

The first edition, known as the International List of Causes of Death, was adopted in 1893. The WHO began co-ordinating the diagnostic system at the time of the sixth revision of the ICD in 1948. This version included causes of morbidity for the first time [106].The *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (ICD-10) is the most recent diagnostic coding system. Australia currently uses the Australian Modification of ICD-10 (ICD-10-AM) [157].

For a case to be definitively classified as an alcohol-related injury, the principal diagnosis would need to be an injury as designated by an ICD diagnostic code between S00.0 and T98.3 (Chapter XIX, ICD-10-AM) *and* the case record would have to include an ICD-10 code specifically relating to alcohol. Examples of purely alcohol-attributable ICD-10 codes include F10 ("Mental and behavioural disorders due to use of alcohol"); K85.2 ("Alcohol-induced acute pancreatitis"); R78.0 ("Finding of alcohol in the blood"); T51 ("Toxic effect of alcohol"); X45 ("Accidental poisoning by and exposure to alcohol"); X65 ("Intentional self-poisoning by and exposure to alcohol"); Y90 ("Evidence of alcohol-involvement determined by blood alcohol level"); Y91 ("Evidence of alcohol-involvement determined by level of intoxication") , and Z72.1 ("Problems relating to lifestyle: alcohol use") [106].Therefore, two ICD-10 codes would have to be included in the patient's record. The exception to this is the ICD-10 code T51 ("Alcohol poisoning") which is both an injury and specifically alcohol-related.

Alternatively, the ICD-10 codes may be used to infer alcohol-involvement in a condition. The aetiological fraction method may be used to infer the number of alcohol-attributable cases: the total number of cases with a condition is multiplied by the population aetiological fraction to estimate the number of cases wholly attributable to alcohol [109]. Chikritzhs and colleagues describe the aetiological fraction as *"a function of both the strength of the causal relationship between a particular level of drinking and the condition (measured as a 'relative risk') and the prevalence of 'at risk' drinking levels in the population. The strength of the relationship between the exposure and outcome is determined from existing epidemiological studies"* (p. 3 [109]).

For the first time, the Y90 and Y91 codes were included in the 10th revision of the ICD [106]. The Y90 sub-codes define nine blood alcohol level categories, while the Y91 sub-codes enable clinical assessment of four levels of intoxication using a set of physical signs (in the absence of BAC data) [90]. Research has attempted to measure the level of agreement between the two code categories. The results suggest that, while the Y90 and Y91 codes are correlated with each other, the degree of correlation varies across countries [158].

Furthermore, these codes are not commonly used in Australia. For example, a study of the involvement of alcohol in workplace injuries in Australia noted that only in 0.22% of 938 work- and non-work-related hospital cases was one of these codes used [159].

Because of time constraints in an ED, additional alcohol-related ICD-10 codes may not be included in patients' records when the primary diagnosis is an injury (for example, a fracture or a traumatic brain injury). This is reflected in ED-focused research. A survey of two EDs in Sydney demonstrated that diagnostic codes (ICD-9, the previous version of the code) detected only 7% (five out of 77) of all alcohol-related presentations [160]. A study of hospital separations (patient departures) across four Australian states detected 38% of 442 alcohol-related injuries by searching for alcohol-related ICD-10 codes; the records included no Y90 or Y91 codes [161]. Ninety-four per cent of these were identified through reviews of medical texts, demonstrating that diagnostic codes may underestimate alcohol-involvement. In an American study, Treno and colleagues showed that 75% of trauma cases with positive BACs were identifiable using the ICD-9 codes to categorise patients' records [147].

3.4.5 Clinical suspicion of alcohol-involvement

Research examining trauma doctors' and nurses' judgement of patients' clinical intoxication ('clinical suspicion') has indicated that males, aged 18 to 44, with a dishevelled appearance, perceived low income or without insurance, are more likely to be suspected of intoxication [162]. When compared to a BAC measurement, both the sensitivity and specificity of the clinicians' suspicion of intoxication were poor: 23% of intoxicated patients were not identified. A study by Li aimed to assess alcohol-involvement by asking nurses to record it if a patient presented at an ED with an alcohol odour [145]. Out of a total of 945 road crash cases recorded, the nurses at two EDs in Taiwan correctly classified the status of 85% of cases, in alignment with BAC measures. This method may represent an accurate and inexpensive method of assessing alcohol-involvement. However, it may be prone to low inter-tester reliability, and the assessment of those who have consumed stronger smelling alcoholic beverages (e.g. wine or beer) may be more reliable than of those who have consumed spirits [145].

3.4.6 Surrogate measures

Using a surrogate measure of alcohol-related injury establishes likely alcohol-involvement, based on the assumption that alcohol-involvement in harms follows certain temporal, geographical, demographic and anatomical patterns [163, 164]. Surrogate measures have been well described and widely applied in alcohol monitoring and epidemiology [165, 166]. Using a surrogate or proxy measure of alcohol-involvement in injury is a viable alternative to other measures such as BAC and self-reported alcohol use, particularly for monitoring trends in alcohol-involvement in injury over time.

Using a surrogate measure entails reporting the prevalence of harms with a known high alcohol-involvement, and using routinely collected data such as police records, ED or hospital discharge records. This makes it a cost-effective and readily available method for studies investigating community-based interventions and regulatory changes such as alcohol trading hours or alcohol outlet density [164]. In the absence of reliable routinely collected data, the use of a well-defined surrogate measure can maximise the number of alcohol-related incidents identified while minimising inclusion of non-alcohol-related injuries (maximising both sensitivity and specificity) [163, 165-168]. However, it should be noted that a surrogate measure may be used to demonstrate relative changes or trends in rates of alcohol-related injury over time, but it cannot show absolute changes in rates [163].

Research in Australia in the last 20 years has explored the temporal patterns of alcohol-involved incidents, particularly those involving violence. Ireland and Thommeny [6] analysed data on alcohol-related incidents collected by police across Sydney. The officers judged whether alcohol had been consumed, based on their interlocutors' breath, speech, eyes, behaviour and balance (that is, subjective suspicion of alcohol use). Of 684 incidents recorded over four weeks, 260 were 'street offence incidents' including assault and offensive behaviour. The majority (77%) of 'street offence incidents' were assessed by police as alcohol-related. A particularly high proportion of alcohol-related street incidents occurred on a Saturday. In addition, 91% of incidents occurring between 10 pm and 2 am were judged to be alcohol-related. A high proportion of alcohol-related incidents (77%) occurred between 2 am and 6 am. The findings of this study point to time of presentation as a possible surrogate measure of alcohol-involvement.

In WA, Stockwell and colleagues showed that, when demographic factors were controlled for, assaults occurring between 10 pm and 6 am were associated with alcohol sales [169]. Similarly, Briscoe and Donnelly demonstrated that 36% of assaults at licensed premises in inner Sydney between July 1998 and June 2000 occurred between midnight and

3 am. Furthermore, 66% of assaults occurred on weekends, with a large proportion occurring in the early hours of Sunday morning [170].

Internationally, temporal surrogate measures for alcohol-involvement have been developed from studies of road crashes [171, 172] and ED injuries [168, 173]. Heeren and colleagues compared daytime crashes (as a proxy for non-alcohol-related crashes) to several categories of night-time crashes, as potential proxies for alcohol-involvement [171]. The possible surrogate factors explored were time of crash, male gender, age (under 26 years), single vehicle involvement, and fatal crashes. The authors proposed that a 'best' surrogate measure should be a category with a high number of crashes, but which included a high proportion of crashes involving alcohol. Night-time fatal crashes best met these criteria. The weakness of this surrogate measure was that, when compared to BAC measurements, it did not accurately reflect trends over time [171].

In road safety research, single-vehicle night-time crashes (SVN) have been the most frequently used surrogate measure of alcohol-involvement in crashes [174-178]. Rogers concluded that SVN was a stronger indicator of alcohol-involvement than total night-time crashes [179]. The association between confirmed positive BAC and night-time crashes has been demonstrated in other studies, both in Australia [180] and internationally [181, 182]. Australian research has suggested a time-based surrogate of alcohol-related serious crashes: weekend night-time crashes occurring between 10 pm and 2 am [183]. More recently, Voas confirmed the validity of using night-time fatal and non-fatal crashes as an indicator of alcohol-related crashes [172]. Surrogate measures of alcohol-involvement in crashes have been used to design education programs for servers of alcohol at outlets [174, 177], to assess the effects of the privatisation of state monopolies [176] and in moves to lower legally permissible BAC levels [178, 179]. Despite the usefulness of road crash surrogates, they have limitations. For example, road crash surrogates may successfully identify likely alcohol-involved crashes and drink-drivers, but they cannot estimate alcohol-involvement in injured passengers [167].

International studies have demonstrated that mortality due to acute intoxication is highest over weekends[169, 184]; and that fatal alcohol-related non-traffic injuries peak over weekends and between 6 pm and 6 am [185]. Further studies have investigated the temporal, demographic and anatomical patterns associated with alcohol-related injuries [140, 167, 173, 186].

In a series of papers, Treno and colleagues compared several methods of identifying alcohol-related injury in Californian trauma centres: BAC; demographic background; time of day and day of the week; cause of injury using E-codes (external cause of injury codes); ICD-9 diagnostic codes of trauma cases; telephone surveys; ED interviews; and routinely collected data from hospital inpatient records [146, 147, 167]. The authors found that the factors consistently associated with alcohol-involved injury were male gender, age between 21 and 34 years, and late-evening or early-morning presentations (especially over the weekends) at the ED. The alcohol-related injuries included a large proportion of intracranial and open wounds of the head and neck, as well as superficial injuries [147]. The authors concluded that using hospital discharge data entailing a high probability of alcohol-involvement was a cost-effective surrogate for evaluating community alcohol-related injury prevention programs [167].

ED studies have confirmed the association between the day and time of presentation and alcohol-related injury. An international review of ED injury studies up to 1993 indicated that those presenting with an alcohol-related injury were more likely to be male, between 25 and 45 years and to present at EDs in the evening or early morning hours of the weekend [24]. In a Finnish city ED, alcohol-related head trauma presentations peaked over weekends [187]. Among injured patients interviewed at a Swiss ED, half of those presenting between midnight and 8 am, and 80% of those presenting on a Friday and Saturday night, reported consuming alcohol prior to their injury [173]. McLeod and colleagues estimated that more than 30% of injury presentations between 6 pm and 6 am at a Perth ED were associated with alcohol (compared to 11.2% of daytime injury presentations) [186]. A study conducted in an inner-city ED in Sydney found that 60% of those with alcohol-related injuries presented between 6 pm on Friday night and 6 am on Monday morning [140].

The patterns observed in previous research into alcohol-related ED presentations have led to the development of a surrogate measure of alcohol-related presentations. Young and colleagues used a subset of 8,580 cases across five countries and 28 EDs from the ERCAAP dataset [168]. The study pooled data from EDs in the US, Mexico, Canada, Australia, Spain and Italy. Most of the data came from the USA (49.5%) and Mexico (22.1%).The dataset contained both BAC and self-reported alcohol consumption in the six hours prior to injury. Young et al. analysed trends in alcohol consumption and injury across various demographic and time-based factors, and determined the proportion of alcohol-involved cases for each factor. The five factors investigated were sex, age, marital status, day of injury and hour of injury. The authors established that the strongest predictors of alcohol-involvement were presentations between midnight and 4:59 am (OR = 4.92) and male gender (OR = 3.01) [168].

In the WA ED sub-sample (Fremantle Hospital ED), 71% of the injury cases presenting between midnight and 4:59 am were alcohol-related. Seventy-five per cent of young single males presenting at all EDs with an injury between midnight and 4 am on a Friday, Saturday or Sunday had recently consumed alcohol. However, these cases accounted for less than 3.4% of the total sample, so using this surrogate would result in only small numbers of cases being available for further study. Because 56% of cases presenting between midnight and 4:59 am had consumed alcohol, this was chosen as the best surrogate measure for evaluating community-based alcohol-related injury prevention efforts. Weekend night-time ED presentations were recently used as a surrogate measure of alcohol-related injury in an ED study in regional and remote Victoria [188].

As the specific night-time hours with high risk of alcohol-related injury might vary according to the trading hours in the local area [90], researchers have recommended that surrogates should be adjusted and validated for the location being studied [168, 173].

An approach to verifying a surrogate measure of alcohol-related ED presentations was recently established by Evans et al. for South Australian EDs [164]. This involved examining the temporal distribution of ED cases in South Australia known to be directly attributable to alcohol and identifiable from ICD-10 primary diagnostic codes, such alcohol poisoning (T51.0), alcohol intoxication (F10.0) and alcohol-induced acute pancreatitis (K85.2) [106], and identifying peak times of presentation.

In summary, assessing the presence of alcohol in ED presentations continues to be a challenge facing both clinicians and researchers. In the absence of mandatory BAC testing, using a surrogate of alcohol-involvement provides a cost-effective method of assessing alcohol-involvement in EDs for researchers.

3.5 The availability of alcohol and its relationship to alcohol-related harms

Alcohol availability refers to the accessibility of alcohol in a given environment [189]. Four main types of availability have been described in the literature, namely social, subjective, physical and economic availability.

Subjective availability refers to *"how accessible people feel that alcohol is to them"* (p. 123 [42]) and includes perceptions and beliefs about the ease of obtaining alcohol. This includes willingness to travel in order to obtain alcohol, perceived convenience of buying alcohol, and the importance of price to an individual [190].

Social availability is defined as *"availability within small social or family groups"* (p. 124 [42]). This includes the drinking behaviour within an individual's social network, the perceived obligation to serve and consume alcohol at social events, and drinking alcohol for social reasons [190].

Physical availability includes the likelihood of coming into contact with outlets providing alcohol [191]. Physical availability can be defined as *"actual legal, organisational and geographical factors that affect the cost of acquiring alcohol"* (p. 383 [189]). Other aspects of availability may, at an individual-level, outweigh physical availability in decisions about alcohol consumption [42, 192]. The level of physical availability is influenced by the legal arrangements made by governments controlling the purchase and consumption of alcohol, including control of trading hours, liquor licensing, minimum drinking age restrictions, beverage types and strength [193]. Alcohol outlet density is a further dimension of physical availability. The term 'outlet density' is used to describe the number of liquor outlets within a defined region and is typically standardised using residential population or a measure of land area or roadway miles [29].

The economic availability or real cost of alcohol is its 'affordability' [42], that is, the price relative to the disposable income of drinkers [30].The real cost (the retail price or price-specific cost) of alcohol is affected by levels of taxation, controls on drink prices (such as minimum price per standard drink), costs of production and levels of consumer demand.

Previous research has shown that alcohol sales and alcohol outlet density affect the economic and physical availability of alcohol in a community and, in turn, the alcohol-related problems that ensue [29].

Early explanations of alcohol-related harms focused on the disease model of alcohol, placing the responsibility for health and social problems on 'alcoholism' [30, 42]. Subsequent explanations have been drawn from the perspectives of public health [4]; sociology [194]; psychology [42]; criminology [195], and economics [196]. Individual theories that have been used to explain the relationship between alcohol availability and harm include availability theory [191, 197, 198], routine activities theory [195, 199, 200], and social disorganisation theory [200, 201]. More recently the niche theory and assortative drinking model of alcohol use, an outlet density-specific theory, has been proposed as specifically explaining the alcohol availability/harm association [194].

3.5.1 Availability theory

Availability theory developed as an alternative to the disease model of alcohol, in which 'alcoholism' was considered to be the primary mechanism underlying alcohol-related harm [30]. The theory offers an explanation for epidemiological evidence which does not fit the disease model, representing a population-based rather than an individual-based framework. Availability theory is applicable to both chronic and acute alcohol-related harms, and to both health and social problems associated with alcohol use [197].

Availability theory was first described by Single [197], framed as the following three postulates:

1. *"Alcohol availability is positively related to mean levels of consumption…over time.*
2. *Mean drinking is related to levels of heavy drinking: the mean level of alcohol consumption...is closely related to the number of persons consuming at levels deemed to be high risk.*
3. *Heavy drinking is associated with adverse health and social consequences."*
   (p. 326 [197])

Single noted that *"even when in moderation, drinking is associated with alcohol-related health and social problems"*, including the risk of developing cirrhosis and of being involved in traffic crash (p. 328 [197]). The author argued that moderate or social drinkers can influence a reduction in the alcohol consumption levels of heavy drinkers. Conversely, heavy drinkers can influence a rise in the alcohol consumption of moderate drinkers. Thus, as the availability of alcohol increases, moderate drinkers tend to become heavy drinkers, increasing the risk of alcohol-related harms. Single conceded that access to alcohol is not the only factor that influences the risk of alcohol-related problems: age, gender, occupation and heredity (among other factors) are also important. Nevertheless, he argued, 'exposure' to alcohol is most readily influenced by public policy [197].

More recently, availability theory was expanded to take into consideration growing epidemiological research [191]. Single's original version of availability theory proposed that increased availability invariably led to increased consumption resulting in increased harms. Stockwell and Gruenewald [191] argued that the relationship among availability, consumption and harm is more complex, and dependent on both environmental and individual contexts. In their explanation, the authors included the concept of the 'convenience cost' of alcohol, also described by Grossman [202]). The concept of convenience cost refers to aspects of both subjective and physical availability: the perceived ease with which alcohol can be obtained and the distance that must be travelled to obtain it [193, 202].

Stockwell and Gruenewald propose two mechanisms which may determine the availability of alcohol: manipulation of the 'full price' of alcohol (retail price plus convenience cost) (and therefore drinking levels); and modification of routine drinking activities[13] implicated in alcohol-related harms within certain subgroups in the population. The original propositions of availability theory were extended as follows:

1. "Greater availability of alcohol in a society will increase the average consumption of its population when such changes reduce the 'full price' of alcohol, i.e. the real price of beverages at retail markets plus the convenience cost of obtaining them.

2. Greater availability of alcohol in a society will directly affect alcohol-related harm when such changes affect the distribution of 'routine drinking activities'; behaviours drinkers engage in when consuming alcohol (e.g. drinking at bars vs. at home; drinking socially vs. alone).

3. Greater average consumption in a population will be related to increases in drinking among some segments of the population along one or more of the several basic dimensions of drinking; rates of abstention, frequencies of use, quantities consumed and variances in drinking levels.

4. Greater adverse health and social problems stemming from alcohol use will appear across the drinking population, focused in those subpopulations most exposed to risk. These risks will be distributed differently across population subgroups, depending upon differences in routine drinking activities (2, above) and drinking patterns (3, above)".

(p. 217 [191]).

3.5.2 Routine activities theory

The routine activities theory is a criminological theory which proposes that the opportunity for 'direct-contact' opportunistic crime[14] (such as assault) exists when three elements converge in time and space: a motivated offender, a suitable victim, and the absence of capable guardians against an incident [203]. Cohen and Felson propose that the absence of one of these three elements is sufficient to prevent such a crime. Brinkman and colleagues explain the theory thus: *"In essence, they suggest that the occurrence of most crime events can be best understood in terms of a combination of certain risk factors for particular crimes (for example, visibility of the act, ease of transport for stolen items) and the daily rhythms and routines of people's lives"* p. 62 [163]). For example, changes in routine activities such as time spent at home, participation in leisure activities or at work, and

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[13] Routine activities theory, which influenced this argument, is discussed in 3.5.2 below.

[14] The term 'direct-contact predatory violations' was used by Cohen and Felson to describe the types of crime explained by routine activities theory [203].

levels of control by the police or members of the community can affect opportunities for alcohol-related harms to occur.

Stockwell argues that *"some combinations of place, time and behaviour generate considerably more problems than others"* (p. 925 [204]). Stockwell's research has shown that licensed premises, specifically hotels and nightclubs, are more likely to be associated with alcohol-related harms [205]. Increased alcohol outlet density provides increased opportunities for potential offenders and victims to converge at a venue. The disinhibiting effect of alcohol can provide the 'motivation' for a potential offender to carry out acts of violence including assault at home or at an outlet [206]. Routine activities theory has been used to explain the association between alcohol outlet density and crime [195]; drinking and driving [207]; college drinking [208]; patterns of drinking by age, gender and ethnicity [199]; child physical abuse and neglect [206], and intimate partner violence [209].

3.5.3 Social disorganisation theory

Social disorganisation[15] theory is an ecological theory stemming from the disciplines of criminology and sociology which proposes that place (the residential location and neighbourhood) is as important, or more important, than individual characteristics such as age, ethnicity and gender in explaining why people commit crimes. The theory links disadvantaged communities with increased risk of crime (such as alcohol-related assault) [211]. The theory proposes that informal control mechanisms[16] can play a mediating role between disadvantage and crime. Essentially, informal social controls are the pressures exerted by community groups (including recreation centres and libraries), friendship networks and the informal monitoring of teenage groups such as gangs [210]. When these informal community controls are reduced through deprivation, the risk of crime increases.

Social disorganisation has been shown to impact on the association between alcohol outlet density and crime. The association is strengthened in more socially disorganised communities [200, 213], and weakened (or removed) in organised communities [214, 215]. Peterson and colleagues established that alcohol-related crimes such as assault are associated with a high density of bars but also with a low density of other retail and recreational facilities (that is, an absence of informal social controls)[211]. Freisthler demonstrated that

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[15] Social disorganisation refers to *'the inability of a community structure to realise the common values of its residents and maintain effective social controls'* (p. 777 [210]).
[16] Informal control mechanisms are *'dispute resolution mechanisms falling outside the scope of the formal justice systems'* [212].

high bar outlet density and social disorganisation (measured by poverty, residential instability, childcare burden, and immigrant population) are independently associated with high rates of child maltreatment [201]. Aspects of social disorganisation (low collective efficacy and residential instability) have also been used to explain youth drinking [216].

3.5.4 Niche theory and assortative drinking

In order to explain why certain alcohol outlets have more problems than others, Gruenewald proposed a new theory explaining patterns and locations of alcohol consumption [194]. The author asserted that differences in alcohol-related harm among outlets (including those of the same type) could be explained by combining niche marketing theory and the concept of assortative drinking. Gruenewald suggests that commercial interests will gradually segment the market according to the interests of different groups of consumers (for example, different bars catering towards young people, middle-aged drinkers, those with different music tastes and so on), creating niches in the market [194]. The theory proposes that drinkers tend to return to outlets where they find people similar to themselves ('assortative drinking'), forming drinking subgroups. This leads to *"greater diversity among those outlets and a greater degree of social stratification of the drinking population"* (p. 875 [194]). Thus, certain outlets are likely to consist of 'higher risk' patrons who are more prone to behaviours that increase the risk of alcohol-related harms.

Furthermore, the characteristics of on-premise outlets can affect social interaction at the premise, which can lead to aggressive behaviour among those who have been drinking heavily [217], especially at establishments that tend to attract people who are predisposed towards these behaviours [194]. Clusters of these 'at-risk' outlets have the potential to become problem 'hotspots'.

3.5.5 Proximity and amenity: mechanisms for explaining the outlet effect

Livingston and colleagues proposed a theoretical framework for alcohol outlet density studies, separating the effects of outlet density into:

> - *"a proximity effect (how easily one can access alcohol); and*
>
> - *an amenity effect (how outlets influence the quality and characteristics of surrounds within the local community)".*
>
> (p. 561[218])

The proximity effect relates to the impact that alcohol outlet density has on the convenience cost of alcohol. According to availability theory, if outlet density increases, alcohol is more accessible (consumers are physically closer to outlets), leading to increased consumption. Livingston and colleagues suggest that the higher numbers of outlets in an area may have the secondary effect of reducing prices (increasing the economic availability) because competition among outlets rises as outlet density increases [218]. The effect on price is likely to be more pronounced where outlets are clustered. The reducing of prices has been associated with rising consumption levels [219]. Thus, increased outlet density potentially increases the accessibility (both affordability and availability) of alcohol and, it is proposed, the levels of consumption and alcohol-related harms.

The amenity effect reflects the negative effects that licensed premises have on the neighbourhoods in which they operate [218]. Alcohol outlets change the quality and characteristics of the area around them, and can act as 'attractors of trouble'. The addition of individual outlets may not produce a linear increase in violence. Beyond a certain threshold, however, clusters of outlets form an 'entertainment district', attracting more people than would be expected from the same number of independently located outlets. This results in crowds of intoxicated people moving between multiple outlets and onto the streets surrounding the outlets. In these conditions, a greater potential exists for incidents of violence and injury [217, 218].

Liang and Chikritzhs [84] propose that the influence of an outlet on harm is mediated by its function. In broad terms this relates to whether the outlet sells alcohol for on- or off-premise consumption. Proximity (encompassing convenience cost and economic availability) appears to facilitate the interaction between off-premises outlets and violence, while amenity, rather than availability, appears to influence the relationship between on-premise outlets and violence via the actual numbers of outlets in a small area.

In summary, several theories have been proposed from different disciplines to explain how population-level factors related to alcohol affect levels of alcohol consumption and harms. The thesis will draw on these theories to explain this study's findings.

3.6 Evidence for associations between alcohol availability and harm: trading hours and price

Alcohol outlet density is one of several factors that are known to influence availability. Other factors affecting availability include (but are not limited to) trading hours of alcohol outlets, sales to minors, government monopolies (physical availability), and retail price (economic availability). The manipulation of any of these aspects can affect levels of consumption and alcohol-related harms [40]. The followin[220]g section provides an overview of the evidence of the association between alcohol-related harms and the two factors most relevant to this thesis: trading hours and price.

3.6.1 Trading hours

Physical availability can be affected by the days and hours of sales [221, 222]. Various limitations on availability have included banning Sunday trading [223, 224]; limiting hours of sale on payday [59], and legislating the closing times of establishments holding certain types of licence, such as hotels[47].

A series of analyses was conducted by Chikritzhs and Stockwell in the same geographical region as this study: Perth, WA [225-227]. Interrupted time-series analysis was used to calculate rates of alcohol-related harm associated with hotels with extended trading hours. Hotels without extended trading hours were used as controls. The study was based on the introduction of so-called Extended Trading Permits (ETPs) which allow certain hotels to trade for an additional one or two hours beyond midnight. A range of outcomes was examined including police-reported assault [225] and road crashes involving alcohol [226]. The authors identified significant positive associations between hotels with ETPs and these outcomes. After adjusting for assault rate trends at hotels without ETPs, analysis showed that assault rates at the hotels increased by more than 70% following the introduction of extended trading hours [225]. Furthermore, the mean crash rate associated with these venues[17] increased by 47% at hotels with ETPs after the extended hours were introduced (after adjusting for crash trends at hotels without ETPs) [226]. Young male drivers drinking at hotels with ETPs had relatively higher breath-alcohol levels than those drinking at hotels with standard trading hours [227]. Much of the association between trading hours and harm was explained by sales volumes, specifically of full-strength beer. The authors concluded that the association between extended trading hours and harms may have been mediated by an increase in the number of patrons and an increase in the volume drunk per patron.

In a systematic review, Stockwell and Chikritzhs examined the literature relating to trading hours (days and hours of sale of alcohol) [222]. A total of 49 studies, most of which were conducted in Australia, the United Kingdom and Canada, met the inclusion criteria. Less than a third (14) of the studies included both baseline measures and a control group. No fixed conclusions could be drawn from the remaining 35 studies. Of the 14 studies with the

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[17] In the police report, the hotel was named as the last place where drinks had been consumed.

strongest study designs, 11 studies reported an increase in rates of harm in terms of at least one outcome measure (road traffic casualties, violent assault and hazardous alcohol consumption). In several of the studies undertaken prior to 1990, rates of harm during the extended trading hours increased. However, Stockwell and Chikritzhs questioned the finding that overall levels of harm (that is, over the total evening hours) did not increase. More recent studies (including the Perth analyses reported above) reported an increase in harms both during the extended trading hours period, and over the total evening trading hours [225-227]. The review concluded that, despite some methodological issues and the need for further well-designed studies, increasing on-premise trading hours resulted in increased alcohol consumption and related harms. This concurred with conclusions drawn by Babor et al. [41] that restricting opening hours and days of outlets impacts both the volume of alcohol consumed and the rates of alcohol-related problems.

A more recent study of 18 Norwegian cities by Rossow and Norström explored the effect on police-reported assault of small changes to trading hours (restricting or increasing trading by up to two hours) at on-premise outlets [228]. The authors demonstrated that a one hour change to trading hours over weekend nights led to a 20% change in violent crime in city centres.

3.6.2 Pricing and taxation

The retail price of alcohol is a component of the economic availability or 'affordability' of alcohol. The price of alcohol can be affected by the physical availability of alcohol, specifically by the density of alcohol outlets, especially when the outlets are clustered. More outlets lead to increased competition (through supply and demand), which exerts a downward pressure on price. For example, an outlet may offer price discounts (such as 'happy hours' and 'two for the price of one' offers) to encourage patrons to choose that outlet over nearby outlets [229]. A recent study examined the effect of partial privatisation of government off-premises outlets in BC, Canada [230]. Treno and colleagues established that an increase in the private (not government-controlled) off-premise outlet density was significantly associated with a lower mean price of beer and total mean alcohol price. Increases in on-premise and government-controlled off-premise outlet densities, however, were not associated with lower mean alcohol prices. The authors demonstrated that patrons at these on-premise and government-controlled off-premise outlets substituted lower quality beverages to reduce expenditure on alcohol.

The retail price of alcohol can be manipulated through government control in several ways: higher taxation (including taxation of specific products such as alcopops), minimum pricing of the alcoholic beverages (per standard drink), and restricting promotions (such as discounting of alcohol). Each of these methods increases the retail price of alcohol, acting as a disincentive to purchase by making alcohol 'less affordable' [231, 232].

Two recent systematic reviews examined the effects of price and taxation on sales and consumption [219] and on morbidity and mortality [233]. The first meta-analysis, which included 112 studies, concluded that a 10% increase in alcohol price resulted in an almost 5% reduction in consumption [219]. This overall effect was similar to that found by Gallet in an earlier economic meta-analysis [234]. Wagenaar and colleagues examined the effect of price and taxation on all types of beverages (beer, wine and spirits), both at the individual and aggregate levels. For each category of drink—beer, wine and spirits—the association between the price of the drink and drinking level was statistically significant. Mean price elasticities[18] were –0.46 for beer, –0.69 for wine and –0.80 for spirits [219].

In a subsequent meta-analysis, Wagenaar and colleagues [233] re-analysed the data from 50 studies into price and alcohol-related morbidity and mortality. The outcomes studied were alcohol-related disease and injury including violence; suicide; traffic crashes; sexually-transmitted infections; other drug use, and crime. All harms (with the exception of suicide) were significantly associated with price. As many of the harms examined may not have followed alcohol use (i.e. prior alcohol use was not confirmed by BAC or self-reports), the authors suggest that the associations between the actual alcohol-related cases and price might be underestimated. The effect size for alcohol morbidity and mortality was large (doubling the tax on alcohol was associated with a 35% decrease in alcohol-related mortality); for traffic crash outcomes the effect size was medium (doubling tax would result in an 11% decrease in traffic deaths). The authors concluded that the evidence strongly suggests that pricing policies have the potential both to reduce alcohol-related harm effectively and to generate revenue to offset the health care costs associated with alcohol use.

A noteworthy English study modelled the effects of 18 pricing policies on consumption, health care costs and quality of life [235]. Specifically, the authors estimated the influence of a minimum price per alcohol unit and restricted price-based promotions on three categories of drinkers: moderate, hazardous and harmful drinkers[19]. Purshouse and

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[18] Price elasticity of demand is a term used by economists and is defined as *'the percentage change in consumption resulting from a 1% change in price. For example, price elasticity for alcohol of –0.5 implies that a 1% increase in its price would reduce alcohol consumption by 0.5%'* (p. 111 [229]).

[19] Purshouse and colleagues define moderate drinking as ≤ 21 units per week for males and ≤ 14 units per week for females; hazardous drinking as >21 < 50 units per week for males and >14 <35 units per

colleagues demonstrated that the effect of a minimum price policy varied considerably depending on the chosen price threshold, suggesting the need for country-specific modelling. The authors identified the point at which the effectiveness of a minimum floor price increased rapidly, and examined the benefit of a differential minimum price for on- and off-premise outlets. Heavy drinkers appeared to be most affected by minimum pricing. The study found that, unless price discounts were either totally banned or heavily controlled, limiting discounts at off-premise outlets was one of the least effective pricing policies to reduce consumption and harm.

Recent research by Stockwell and colleagues in British Columbia, Canada, investigated the association between minimum pricing and consumption [236], and alcohol-attributable deaths [237] over time. Using data from 1989 to 2010, the authors estimated that a 10% increase in minimum price was associated with a 16% reduction in alcohol consumption (relative to non-alcoholic beverages) [236]. Zhao, Stockwell and colleagues, in an analysis using eight years of data, showed that a 10% increase in the minimum price of spirits and liquors was associated with an immediate 35% drop in alcohol-attributable deaths [237]. Significant reductions in total[20] and chronic alcohol-attributable deaths were detected two to three years after an increase in minimum price.

An evaluation was undertaken of the combined effect of the Living With Alcohol (LWA) levy (on beverages with more than 3% alcohol per volume) and the LWA program, which aimed to reduce alcohol-related harm in Australia’s Northern Territory (NT) [238]. The LWA levy, imposed between 1992 and 1997, resulted in a price increase of five cents per standard drink. The evaluation showed that the combined LWA levy and comprehensive LWA program resulted in a significant decrease in acute mortality resulting from acute alcohol-attributable causes, and a significant but delayed reduction in chronic alcohol-attributable mortality [238].

A further Australian study aimed to explore the relationship between price and consumption levels in Central Australia and Greater Darwin [239]. The study established that the beverage with the lowest price was cask wine, with a minimum advertised price of 22 cents per standard drink and an average price of 53 cents per standard drink. Restrictions imposed on the availability of cask wine, and the imposition of an ‘alcopops tax’, were

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week for females; harmful drinking as ≥50 units per week for males and ≥35 units per week for females [235].

[20] Total alcohol-attributable deaths include deaths resulting from both acute and chronic alcohol-attributable causes.

associated with a higher average wholesale price and lower per capita consumption in Darwin.Time series analysis showed that in both Central Australia and Greater Darwin, price was significantly negatively associated with consumption over the 11-year study period.

In summary, research has shown the effectiveness of price increases (through taxation) and minimum pricing both in the reduction of alcohol consumption and in the reduction of alcohol-related mortality. However, less evidence has been adduced for restricting discounting as a means of reducing consumption and harms.

3.7 Evidence for associations between alcohol outlet density and harm

From the 1970s, researchers began to investigate the relationship of alcohol outlet density with consumption levels and alcohol-related harms. Initial studies in the 1970s and 1980s employed relatively unsophisticated study designs and statistical analyses, using aggregated data over large geographical areas, and did not account for the spatial component of data. Over time, statistical methods have evolved to analyse smaller geographical units of analysis, and spatial models have been developed. The outcomes studied have included chronic harms such as cirrhosis, and acute harms, especially violence and road crashes.

The majority of research has been undertaken in the USA, with fewer studies in Scandinavia [13], Australia [29, 240], New Zealand [241] and Canada [242].

3.7.1 Pre-1980s

Research conducted prior to 1980 failed to demonstrate consistently the associations of alcohol availability with alcoholism [243], traffic offences, and road crashes [244]. However, a re-analysis of the data used by Smart [243], which adjusted for potential confounding factors, indicated that outlet density was associated with alcoholism. Associations were demonstrated between problem drinking and various measures of physical availability (such as liquor store employees per 100,000 population) [245], at both on- and off-premise outlets.

It is difficult to compare studies from this pre-1980 time period because of widely differing methodologies and definitions of availability (which were not validated) [246 #340]. Furthermore, data were aggregated to state-level in many studies, which ignored heterogeneity within the states of the USA [247].Underlying these analyses was the assumption that alcohol-related harm primarily involved ‘alcoholics’. The studies measured total alcohol consumption, ignoring the pattern and quantity of drinking per occasion. Furthermore, the time lag between beginning to drink heavily and the development of the effects of chronic harms could have masked the association between harms and outlet density. Studies of this time period did not explore the impact of outlet density on acute harms such as violence and social problems.

3.7.2 1980s

Various analyses undertaken by Colón and colleagues in the early 1980s explored the association of alcohol availability with liver cirrhosis (as an index of alcoholism) and single-vehicle fatalities [248-251]. The studies controlled for more confounding factors than earlier research and included sociocultural and demographic factors as predictors. However, analysis was undertaken at state-level. Colón created an (unvalidated) composite measure of availability consisting of numbers of on- and off-premise outlets, minimum legal drinking age, taxation level, county-level prohibition, and the presence of a state monopoly [251]. This measure was used in several studies of availability over the next decade [252].

Colón and Cutter demonstrated an inverse relationship between on-premise outlet density and single-vehicle fatalities (a proxy for alcohol-involvement in the crash) [250]. The authors hypothesised that, in areas with higher outlet density, the distance to outlets would be less, so drinkers would drive shorter distances to obtain alcohol (lower driving exposure), with a concomitant decrease in the risk of road crashes. Interestingly, the authors note that average beer consumption, but not average overall alcohol consumption, was positively associated with single-vehicle fatalities.

Many of the studies undertaken in the 1970s and 1980s have been criticised for not including relevant socio-economic variables and for using multiple statistical testing procedures, leading to increased probability of a Type 1 error [253]. Several studies, however, included socio-demographic variables (such as socio-economic status, age and gender) and more complex and appropriate statistical methods. For example, Watts and Rabow [247] analysed data for the state of California, USA, at city-level, developing a model that integrated both socio-demographic and availability variables. The authors demonstrated an association of alcohol availability with three outcomes: public drunkenness, drunk driving and cirrhosis mortality.

Rush and Gliksman [254] used causal modelling to conduct a rigorous analysis of data from Ontario, Canada. The authors felt that the method of statistical analysis overcame some of the difficulties of combining different indicators of alcohol-related damage or harms. The measure of availability used in the study (on- and off-premise outlets per 1,000 population) equated to ‘retail availability’, that is, alcohol outlet density. The authors concluded that lower levels of alcohol consumption and alcohol-related harms were associated with policies that decreased outlet density. The addition of socio-demographic factors to the model suggested a causal link between socio-demographic characteristics and outlet density, and ultimately an association with levels of consumption and alcohol-related harms [255].

Despite the strengths of the latter studies, the authors did not explore effects of price and personal income on consumption [253]. Gruenewald and colleagues identified several studies that included price and income in the analyses [253]. Two explored the possible bidirectional relationship between alcohol consumption (‘demand’ in economic terms) and availability (‘supply’). Wilkinson assessed the usefulness of several policies to decrease drunken driving and demonstrated a significant effect of sales on outlet density but not vice versa [256], while Godfrey showed a simultaneous relationship between outlet density and beer sales, but not between outlet density and wine and spirits sales [257]. Gruenewald and colleagues criticised other studies using statistical techniques that might produce biased estimates of effect [258, 259].

3.7.3 1990s

During the 1990s, studies were published that had employed more sophisticated designs and methods of analysis and better controls for confounding factors, as well as accounting for the spatial nature of the data. Groups of researchers began to focus on outlet density research, notably at the Prevention Research Centre of the Pacific Institute for Research and Evaluation (Dr Paul Gruenewald and colleagues), and the Rand Corporation (including Professor Richard Scribner and colleagues). Almost all of the research took place in the USA, and much of it in California.

In the early 1990s, a much-cited study explored the associations between the rates of seven index crimes[21] and the number of taverns and cocktail lounges per city block in

[21] The seven index crimes were murder, rape, robbery, aggravated assault, grand theft, burglary and auto theft. A further three ‘total crime’ categories were included: violent crime, property crime and total crime.

Cleveland [195]. This study marked the beginning of a trend towards using smaller geographic units in the outlet density literature. Roncek and Maier used multiple controls for household composition, socio-economic status and ethnicity. The results implied that small changes in tavern density were associated with substantial changes in all crime rates, with the strongest associations found for block density and assault, and total violent crime.

A study of the city of Rotterdam in the Netherlands, by van Oers and Garretson [260], used ‘neighbourhoods’[22] as the geographic unit to assess correlations between the proportion of drinkers, density of bars and liquor stores, and traffic injuries. The study found that the proportion of drinkers and both liquor shop density and the rate of traffic injuries were significantly correlated. There was also a significant correlation between outlet density and the traffic injury rate. However, because only correlations were reported, it was not possible to gauge the direction of the relationship among the variables.

A study based in Kentucky, USA, used an alternative measure of physical availability, i.e. the distance travelled to access legal alcohol, from each ‘dry’ county (where the sale of alcohol is illegal) to the border of a ‘wet’ county (where alcohol sales are permitted) [261]. The study found that, in contrast with Colón and Cutter’s earlier study [250], distance was significantly and negatively associated with alcohol-related injuries. In other words being closer to legal alcohol was associated with increased rates of alcohol-related crashes. Alcohol-involvement in non-fatal crashes was based on police judgement, rather than more objective measures of alcohol-involvement, therefore crashes may have been misclassified in this study.

In an important initial study in Los Angeles County, USA, Scribner and colleagues explored the association between the density of four types of alcohol outlets and road traffic crashes at city-level [11]. The study included city-level socio-demographic factors in its analysis. The authors found that mini-market and restaurant densities were positively associated with rates of crashes resulting in injuries, and restaurant and bar density were positively associated with crashes entailing property damage. In a further analysis, the authors demonstrated that both on- and off-premise outlet densities were associated with increased assault rates [262].

The same authors analysed the association between outlet density and homicide using a smaller geographic unit (residential census tracts, census tracts being small-

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[22] It was unclear how the geographical unit ‘neighbourhood’ was defined in this study.

population geographic entities within counties defined by visible physical boundaries, a tool used by the US Census Bureau), demonstrating that increased off-premise outlet density was associated with higher rates of homicide [263]. Homicide rates were not associated with either on-premise or total outlet density. Unlike Gruenewald and colleagues [264], Scribner and colleagues did not test for spatial autocorrelation, arguing that that the seriousness of spatial autocorrelation had yet to be determined. (Spatial autocorrelation is discussed in more detail in 3.9.4 below.)

Jewell and Brown analysed the association between outlet density (per miles of roadway) and alcohol-related road crashes [265]. Using miles of roadway as the denominator of outlet density provided a measure of the distance ‘cost’ of travelling to access alcohol. Other predictors of alcohol-related crashes were included: for example, ‘alcohol aversion’ was measured by controlling for religious affiliation. The authors were able to quantify the effect of an additional licensed outlet on the number of alcohol-related fatal and non-fatal collisions.

Gruenewald and colleagues at the Prevention Research Centre in California have published multiple studies since the early 1990s, aiming to integrate theoretical frameworks and empirical research about the association between alcohol outlet density and alcohol-related harms. Initially, the authors used 12 years of state-level panel data to investigate the association between alcohol outlet density and alcohol sales (separately for beer, wine and spirits) [253, 266]. The authors showed that outlet density was associated with wine and beer sales. Following this, the authors analysed the association between outlet density and probable alcohol-related road crashes, using the same 12 years of panel data [267]. In these studies, the authors attempted to overcome some of the limitations of previous cross-sectional studies. The results indicated that the sales of beer, rather than spirits or wine, were most related to single-vehicle night-time fatal crashes. When sales were controlled for, rates of fatal crashes were not associated with outlet density.

A study by Gruenewald explored the spatial relationships between alcohol outlet density and rates of driving after drinking by creating a Geographic Information System (GIS)[23], that included driving events and environmental factors (traffic flow and road network density) [264]. The authors demonstrated that the

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[23] A GIS is defined as *‘a constellation of hardware and software that integrates computer graphics with a relational database for the purpose of managing data about geographic locations’* [268].

outlet density was significantly associated with rates of single-vehicle night-time crashes and that this effect extended to adjacent geographic areas (‘spatial lag’). This study had major implications for the interpretation of past studies and planning future studies accounting for the potential impact of spatial autocorrelation (see 3.9.4).

A case-control study in Georgia, USA, using counties as the geographic unit of analysis, evaluated the usefulness of GIS to assess road crash risk [12]. The study compared alcohol-related and non-alcohol-related single-vehicle crashes. To assess the distribution of crashes, the authors calculated the distance between each crash site and the nearest licensed on-premise outlets and then created 0.5-mile buffer zones around each premise. No associations were demonstrated between distance and alcohol-related crashes, and alcohol-related crashes were not clustered around outlets. This could have been related to the case definition: cases were defined as those arrested for driving while impaired by alcohol, in terms of having a BAC of more than 100 mg/dl. The initial identification of impaired drivers relied on the judgement of police officers, potentially resulting in misclassification of cases and controls. Furthermore, the study used a buffer zone located a very short distance from an outlet (0.5 miles), excluding more distant crashes associated with drinking at the outlet. Both of these factors could have led to a Type 1 error. However, as the authors point out, this study was intended primarily to explore the use of GIS and buffer zones as tools to analyse alcohol-related harm data geographically, and provided a basis for further studies using GIS in outlet density research.

For their research conducted in the state of New Jersey, USA, Gorman, Speer and colleagues examined the association of outlet density with socio-economic level and violence [17, 269-272]. An initial study used GIS to explore the association of race and socio-economic status with outlet density [269]. The study found no association between social disadvantage and high outlet density. The analysis did not disaggregate on- and off-premise outlets. As the mix of outlets (and patterns of alcohol use) varied among neighbourhoods, true associations between socio-economic status and outlet density may have been masked [269].

Gorman and colleagues attempted to replicate Scribner’s study [262] using six years of data at city-level in New Jersey [271]. However, the authors were unable to show an association between outlet density and either violent crime or domestic violence [270]. A re-analysis of the same data, for the city of Newark, used census tracts and census blocks (smaller than census tracts) as the geographic unit of analysis [17]. At census block-level, the analysis established that 27% of variability in violent crime rates was due to socio-demographic factors alone, and 54% of variability was a result of the combined effects of socio-demographic factors and outlet density. Similarly to the study by Scribner and colleagues [263], this study did not test for spatial autocorrelation. Further research of outlet density and violent crime in another New Jersey city at census block and tract level tested for spatial autocorrelation [272]. The study did not reveal significant residual autocorrelation but again confirmed the violence/outlet density association at small area-level.

A further study by Alaniz and colleagues [273] at block group-level examined youth violence among immigrants. This study, which controlled for spatial autocorrelation, revealed a significant association between youth violence and off-premise outlet density.

3.7.4 2000 onwards

In recent years, there has been an increase in the number of studies investigating the impact of alcohol outlet density, using more complex statistical methods across different countries and examining a wider range of alcohol-related harms. Studies into outlet density have ranged from the purely ecological [13, 274] to multi-level studies using individual-level data (through surveys or interviews) and community-level data [275-277]. Studies have been conducted at various geographic levels: functional geographic units ('neighbourhoods') [200, 278, 279]; meshblock-level [280, 281]; census block-level [216, 282]; census tract-level [283-285]; postcode-level [15, 286, 287]; local government area [288]; state-level [289], and country-level [13]). In addition, studies testing for and modelling to accommodate spatial autocorrelation have become more common (see 3.9.4 for further discussion of this issue). While most studies have explored the 'proximity effect' of outlets, two studies from Australia have investigated the 'amenity' or second-hand effects of alcohol outlets on their neighbourhoods [80, 290, 291].

Alcohol outlet density and the road

LaScala and colleagues investigated the association between rates of pedestrian injury and outlet density, using both group-level data (environmental, socio-economic and demographic variables) and individual-level survey data (levels and patterns of drinking) [292, 293]. Using spatial models, the authors demonstrated a significant association between neighbourhood bar density and pedestrian injury rates. A higher unemployment rate, higher population density and higher consumption levels per drinking session were also positively associated with pedestrian injury rates.

Gruenewald and colleagues examined the effects of individual drinking habits and outlet density concurrently, and how they were associated with driving after drinking or while intoxicated [294]. The authors hypothesised that the significant association between restaurant density and driving after drinking might be mediated by higher income, as this group of drinkers was likely to have more available income to use on travel by car and on restaurant meals. The study failed to show a significant association between driving while intoxicated and outlet density. The authors suggested that choosing to drive while intoxicated might be a decision based on individual-level factors, and be less affected by environmental factors such as outlet density.

Using 22 years of panel data, Baughman and colleagues compared alcohol-involved road crashes in wet and dry counties [295]. The analysis accounted for the type of alcohol which could be sold in a county; whether sales were permitted at on- and off-premise outlets; and changes in regulations over time. The study found that, controlling for all county effects and time trends, local access to alcohol (that is, living in a wet county) decreased the expected number of crashes by 4%. Local access to higher alcohol content liquor (spirits), however, was associated with a greater risk to road safety than access to beer and wine alone.

Escobedo and Ortiz conducted a county-level study into alcohol-related driving incidents, suicide, homicide and alcohol-related deaths in New Mexico [296]. The study found that suicide and alcohol-related crash rates increased by 50% and alcohol-related crash fatality rates doubled from the lowest to the highest category of outlet density.

McCarthy explored the effect of outlet density on alcohol-related road crashes at small-town level (populations less than 50,000) in California [297]. The results suggested that higher off-premise density was associated with fewer alcohol-related crashes. Conversely, higher on-premise density was associated with more alcohol-related crashes. The study controlled for only a limited number of socio-demographic variables (unemployment and population density), a factor that could have influenced the results.

Using time series multiple-order autoregressive models, McCarthy explored a range of predictors of road crashes among older drivers (over 60 years old) in California, USA, which included income, unemployment, traffic enforcement, weather conditions, a lower legal BAC for driving, and increasing the speed limit on certain roads [298]. The author included a proxy for alcohol consumption (cirrhosis deaths) that predicted both alcohol-related and non-alcohol-related crashes. A one per cent increase in alcohol outlet density (per square mile) was associated with a 1.2% increase in older-driver crashes, and 1.7% increase in older-driver fatal crashes.

Meliker and colleagues undertook both spatial and traditional analyses of alcohol-related motor vehicle crashes in small cities (<50,000 population) in Michigan, USA [299]. ED and mortuary presentations with confirmed BACs above the legal limit in Michigan were linked with police reports of road crashes. The authors demonstrated that, although more alcohol-related crashes occurred in low population density areas, there was no difference in the density of clustering of alcohol-related and non-alcohol-related crashes in similar areas. Furthermore, there was no significant difference in distance from outlets to alcohol-involved crashes compared to non-alcohol-involved crashes and no significant association between outlet density and alcohol-related crashes. However, for a crash to be considered ‘alcohol-related’ in the study, the driver had to have a BAC above the legal BAC (>0.10%). Cases with a BAC of between 0.05% and 0.10% were therefore classified as non-alcohol-related. Since some impairment in driving begins to occur at any BAC above zero, and since the majority of studies report impairment at a BAC of 0.05% [300], this method of classification could have led to the exclusion of many crashes with alcohol-impaired drivers.

A longitudinal study, conducted in California, USA, used six years of panel data at postcode-level. The study explored the relationship between outlet density and alcohol-related crashes, controlling for population and place variables [16]. Using police records (which indicated the place of last drink) and hospital discharge data (indicating place of residence), the authors found that changes in outlet density over time were positively associated with traffic injury rates. Specifically, both local off-premise outlets and bars were positively associated with alcohol-related crashes. A 10% increase in off-premise outlet density was associated with between 0.90% and 0.93% increase in alcohol-related crashes (using police reports and hospital discharge data respectively). Smaller effect sizes were demonstrated for bar densities, with a 10% increase being associated with a 0.51% increase in hospital discharges and a 0.43% increase in police-reported alcohol-related crashes. The effect of restaurant densities on alcohol-related harms was mixed, possibly because the main function of restaurants is to provide meals. The study noted that both place of residence and place of purchase affected the likelihood of alcohol-related collisions, and indicated that demographic characteristics had a greater impact on crash rates than alcohol outlet density.

A study by Truong and Sturm [283] investigated the association of counts of outlets with individual consumption and driving behaviour in California, USA. The location of alcohol outlets and the census tracts of residences of surveyed drinkers were plotted to create a GIS. Three buffer zones, at 0.5-mile intervals, were created around the boundary of the census tract in which each residence was located. Using buffer zones removed artificial administrative boundaries such as postcodes from the analyses. This allowed drinking behaviour across postcode or census tract borders to be modelled (avoiding the usual difficulties when using artificial administrative boundaries, the so-called Modifiable Areal Unit Problem[24]). Deceptively low outlet densities may be calculated in areas with unpopulated sections (using distance as the denominator) or highly populated small areas (when population is used as a denominator). Using counts of outlets avoids misleading measures of availability.

The authors used multiple measures of individual-level ‘problem’ drinking including high consumption per month, heavy drinking episodes, driving after drinking, and riding with drinking drivers. The findings showed that although counts of off-premise outlets were not associated with any measures of problem drinking, counts of on-premise minor-restricted licences were consistently and significantly associated with high monthly and heavy episodic drinking. The positive association between alcohol availability and problem drinking diminished as the distance from residence to outlet increased.

A further study by Gruenewald and Johnson included traffic flow and roadway network density as further predictors of single-vehicle night-time crashes [301]. The authors explored several models, demonstrating that the association between outlet density and crash rates was mediated by traffic flow. For different levels of traffic flow, a 10% increase in outlet density was associated with increases of between 0% and 150% in crash rates.

In a study set in Manukau City, a large city in New Zealand, Cameron and colleagues examined the association between multiple police-reported incidents including

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[24] Modifiable Areal Unit Problem relates to the effect that artificial administrative boundaries (for example postcode and local government area boundaries) can have on relationships—leading to misleading associations [288].

road crashes, and outlet density [302]. The authors showed that an additional off-premise licence at suburb-level was associated with 10 further road crashes. On-premise outlet density was not significantly associated with road crashes. The authors argue that the conflicting relationships described in the literature are accounted for by the relative influence of two factors: high off-premise outlet density resulting in outlets being relatively accessible to places of residence, leading to higher consumption levels; and low density leading to longer travel times to and from outlets, therefore leading to higher exposure to the road.

Violence, assault and crime

Violence is probably the most extensively investigated harm associated with alcohol outlet density. In the first longitudinal study investigating the relationship between alcohol outlet density and crime, Norström analysed 35 years of country-level Norwegian data [13]. Dummy variables were used to account for legal and data collection changes which could have influenced the reporting of investigated and convicted crimes over the study period. The final model indicated that one unit increase in outlet density was associated with an increase of 0.9 investigated violent crimes per year.

Costanza and colleagues explored how on- and off-premise outlet densities were associated with violent crime at block group-level in Baton Rouge, Louisiana [282]. Controlling for spatial lag, social disorganisation and routine activities, the authors demonstrated a significant association between off-premise outlet density (per 100 households) and both robbery and assault. However, the results did not reveal a significant association between on-premise outlet density (bar and tavern density) and these crimes. The authors explained these results with reference to routine activities theory: bars and taverns provided the ‘guardians’ (in the form of bouncers or bartenders) who prevented violent incidents. Off-premise outlets lacked these guardians, resulting in conditions which encouraged violent incidents.

Similarly, a study of street robbery used a unique, functional geographic unit (face blocks, which are located on both sides of a street between two intersections) to measure density of alcohol outlets [200]. Smith et al. demonstrated that for every additional bar, restaurant or gas station, there was a 5% increase in robbery.

In a series of analyses examining the association between alcohol outlet density and crime at census tract-level, Gyimah-Brempong and colleagues established links between several crimes and outlet density using both linear parametric [303] and non-parametric non-linear models [304]. The latter models explained twice as much variation in crime as the linear parametric models. When outlet density reached 10 licences per census tract, crime rates doubled [304]. Furthermore, the authors concluded that lower income neighbourhoods had higher outlet density, but that it was high outlet density, not low income, that was directly associated with increased crime rates [305].

In a study at census tract-level, Nielsen and Martinez explored the effect of outlet density on black and Latino residents of Miami, USA [306, 307]. The analyses, unlike Gyimah-Brempong and colleagues' studies [303-305], used spatial lag variables to control for spatial autocorrelation. The authors showed that both the proportion of immigrants and total outlet density were significantly associated with robbery and aggravated assault [306]. The authors then analysed black and Latino violence rates separately, using controls specific to each ethnic group [307]. This analysis revealed that total outlet density was associated with robbery and aggravated assault rates among Miami Latino, but not black, residents. The authors hypothesised that levels of disadvantage might have reached a 'tipping point' or threshold in black communities beyond which alcohol availability could have no further impact on rates of violence.

In one of the few studies of outlet density in a developing country, a profile was created of the liquor outlets in a densely populated, violent residential area of Sao Paulo, Brazil [308]. Based on the survey responses, a very high outlet density was calculated (29 outlets per kilometre), and the authors established that only 35% of 63 respondents' outlets had a liquor licence. Hours of sale were not enforced; most outlets closed for the day when the number of patrons dropped. The study illustrated how high outlet density, with a large proportion of unlicensed outlets and high consumption of inexpensive local spirits, existed in a violent neighbourhood.

Reid and colleagues studied the outlet density/violence relationship in Kansas City, Missouri, USA[309]. The analysis used the same variables as Scribner and colleagues' classic study on outlet density and violence [262] but was conducted at census tract level. The study used homicide, rape, robbery and aggravated assault as outcome variables. Sixty-one per cent of the variance of the violent crime rate was explained by various socio-demographic factors, with an additional 9% explained by outlet density.

Zhu et al. undertook a cross-sectional study of two Texas cities in the USA (San Antonio and Austin), at census tract-level [14]. The models included several neighbourhood characteristics assessing disadvantage and residential instability as well as demographic characteristics, and controlled for spatial autocorrelation. Outlet density was statistically significantly associated with police-reported violent crime in both cities. The final spatial model accounted for 56% and 71% of the variance in violent crime in San Antonio and Austin respectively.

Lipton and Gruenewald used cross-sectional data to explore the association of self-reported assault cases with population density and outlet density (using a geographically-based rather than a population-based denominator) [310]. Higher outlet densities of bars and off-premise outlets were associated with an increase in assaults per roadway mile. A model containing population density alone accounted for 57% of the variance of assault rates. The variance explained by the model increased to 67% and 88% with the addition of outlet density and population characteristics respectively.

Gorman et al. explored the associations of violent crime with alcohol outlet density and drug availability (using drug crime rates as a proxy for drug availability), at census tract-level in Houston, Texas, USA [311]. The authors constructed several models which included alcohol outlet density, drug crime rates and socio-demographic factors. Forty per cent of the variability of violent crime was explained by socio-demographic factors alone. Adding crime rates to the model explained 72% of the variability in violent crime, while adding outlet density explained 73% of the variability. After controlling for spatial autocorrelation, off-premise (but not on-premise) outlet density was significantly positively associated with violent crime. Drug availability was more strongly associated with violent crime than alcohol outlet density. The results suggested an interactive effect between drug and alcohol availability.

Britt and colleagues used a functional geographic unit, self-identified ‘neighbourhoods’, in their analysis of cross-sectional criminal violence data in Minneapolis, Minnesota, USA [278]. The authors argue that the density of outlets was linked to people’s activities at neighbourhood-level (rather than at individual-level). This informed their choice of geographic unit. Using Bayesian probability methods, the authors concluded that an increase of one alcohol outlet per neighbourhood was associated with a further five violent crimes per 1,000 individuals in that neighbourhood.

Gruenewald and colleagues undertook an analysis of more than 1,600 postcodes in California to investigate how geographic distributions of population and place characteristics contributed to violent crime [286]. The cross-sectional study revealed that assault rates were positively associated with population size, decreased population density and unstable neighbourhoods. Greater local off-licence density and adjacent postcode population were associated with higher rates of assault. Bar density was positively associated with assault rates among the unstable poor and rural majority areas, but negatively associated with assault rates in more stable neighbourhoods.

Following this study, Gruenewald and Remer [19] used six years of postcode-level data in California to examine the associations of both local and lagged population and place, and assault rates. The authors demonstrated that a 10% increase in median household income was associated with an 8% drop in assaults. An increase in bar density had a much smaller impact on assault numbers. An increase of one bar per postcode was associated with 0.17 additional hospitalised assaults per year. The results of this longitudinal study strengthened the evidence for the alcohol outlet density/violence association.

Two further longitudinal analyses, undertaken by Yu and colleagues, used a natural experiment to explore the effects of a sudden drop in alcohol outlet density. In 1992, civil unrest in Los Angeles, USA, resulted in considerable property damage and the surrender of many liquor licences [284, 312]. The authors compared 10-year trends in violent assaultive crime in census tracts where liquor licences had been surrendered, to violent crime in census tracts where the number of liquor outlets had remained constant [284]. Controlling for spatial autocorrelation, the models showed that the rates of assaultive violence had decreased faster than expected for approximately five years after the sudden drop in outlet density in the affected census tracts. In an additional analysis of the same data, the authors used hierarchical additive models to examine the same data [312]. These models indicated that, although total outlet density was a relatively important predictor of violence, poverty was the most important predicator of rates of assaultive violence in Los Angeles. However, the models indicated that the sudden surrender of licences had no significant effect on violence rates. The authors concluded that the latter analysis showed "*superior performance in exploring important variables that explain the change in the assault rates*" compared to the former method of analysis. Despite the contradictory results provided by two model types, both analyses confirmed an association between outlet density and rates of assaultive violence over time.

Branas and colleagues undertook a case-control study exploring levels of alcohol consumption and outlet density as predictors of gun violence [313]. The control group was matched with 677 persons involved in gun violence according to the time and date of the shooting, gender, age-group, and race. The study demonstrated that the risk of gun assault was similar for individuals near off-premise outlets and those engaging in heavy drinking. Heavy drinking near areas with a high density of off-premise outlets was significantly associated with gun violence.

A further cross-sectional study at census tract-level, conducted in Washington, D.C., USA, investigated the association between crime and alcohol outlet density at census tract-level [314]. The authors demonstrated that the addition of one alcohol outlet was associated with a 4% increase in assaultive violence. Total outlet density was significantly associated with robbery, assault and sexual offences, but not with homicide.

Connor and colleagues examined the associations of alcohol outlets with both self-reported consumption and harm across New Zealand [241]. The results indicated a significant association between off-premise outlet density and binge drinking (a 4% increase in the odds of binge drinking with each additional outlet), but not between mean consumption per year and outlet density. Significant associations were demonstrated among densities of restaurants, bars, off-licences and clubs, and an index of alcohol-related harms. The association was strongest between club density and harms.

Instead of measuring global spatial autocorrelation, Grubesic and Pridemore analysed local- level spatial dependence [315]. The authors assessed the clustering of alcohol outlets and how this was associated with simple and aggravated assaults in Cincinnati, Ohio, USA. The analysis showed that assaultive violence tends to occur around clusters of alcohol outlets, with denser clusters of outlets being associated with higher rates of assault. The magnitude of the association with assault varied according to each outlet's specifically different radius from the clustered outlets.

In 1947, the state of New Jersey imposed restrictions on the number of alcohol outlets permitted per population (one on-premise outlet per 3,000 population and one off-premise outlet per 7,500 population). Schwester explored the association between restricted outlet density and crime at municipality-level in New Jersey, USA [316]. Significant associations were demonstrated between (restricted) on-premise outlet density and both non-violent and violent crime. An increase of one on-premise outlet per 1,000 population was associated with increases of 2.2 violent and non-violent crimes and 2.4 non-violent crimes per 1,000 population. Poverty was again identified as a more important predictor of violent crime than on-premise outlet density. There was no significant association between (restricted) off-premise outlet density and crime in this study [316], possibly because the restricted off-premise outlet density was sufficiently low to minimise crime associated with alcohol outlets.

Guo and colleagues undertook an analysis of larger cities and communities in Los Angeles County, USA [317]. The association of outlet density (grouped in tertiles) with violence, traffic crashes and alcohol-related violence was examined. Logistic regression models were developed, adjusting only for the Economic Hardship Index (calculated by the US Census). On-premise density was significantly positively associated with both violent crime and traffic crashes, while off-premise density was positively associated with violent crime.

The New Zealand study by Day and colleagues (discussed further above) confirmed a significant association between smaller distances to outlets and high rates of violent crime [318]. The relationship decreased in strength and significance as distance to the nearest on-premise outlet increased. The association between off-premise outlets and violent crime remained significant at greater distances to the nearest outlet.

Toomey and colleagues conducted a cross-sectional study at neighbourhood-level in Minneapolis, Minnesota, USA [279]. The study aimed, by using a Bayesian hierarchical inference approach and controlling for spatial autocorrelation, to measure the associations between outlet density and several categories of violent crime (rape, assault and robbery). The analysis demonstrated that significant positive associations existed between both total outlet density and on-premise outlet density, and all categories of violent crime. A 20% increase in on-premise outlet density was associated with a 3.3% to 3.8% increase in violent crime. While associations between off-premise outlet density and categories of violent crime were positive, they were smaller and, in some categories, not significant—the small number of off-premise outlets in the study area may have influenced this.

In a recent longitudinal analysis of 14 years of Californian data, Mair and colleagues used Bayesian space-time models to explore the association between outlet density (especially bar density) and hospitalised assaults [319]. The authors investigated the effects of density of outlets in adjacent postcodes on local assaults. The postcode-level analysis revealed a positive association between bar density in adjacent postcodes and hospitalised assaults. The authors explored interactions between demographic variables and measures of outlet density. The association between assault and outlet density was stronger in neighbourhoods with high population densities and proportions of minority ethnic groups than in wealthier suburban neighbourhoods.

Youth and adolescents

In the last decade, a body of (primarily American) research has accumulated investigating the effects of alcohol availability on adolescents and youth. Many of these studies have measured risky consumption and behaviour, rather than alcohol-related harm, but have been incorporated in this review because of the importance of this subgroup of drinkers.

Wechsler and colleagues explored the effects of others' drinking on adults who lived in the neighbourhoods close to university or college campuses in the USA [290]. These effects are similar to the 'amenity effect' on neighbourhoods with alcohol outlets proposed by Livingston and colleagues [218]. The second-hand effects in Wechsler and colleagues' study included litter, noise, vandalism, vomiting and urination, and drunkenness. The study, which relied on self-reported distance from home to colleges and alcohol outlets, suggested that residents living within a mile of a college were significantly more likely to report these effects than those living further away from a college. Surprisingly, only a small number of participants attributed the effects to the college students. A path analysis indicated that alcohol outlets mediated the association between distance to the nearest college and negative second-hand effects. No direct association was demonstrated between distance from a college to a place of residence and second- hand effects. Alcohol outlets also mediated the association between college binge drinking levels and second-hand effects. This indirect relationship was much stronger than the direct association between drinking levels and reported problems. This study was limited in that it relied on self-reported data, measuring perceptions by residents rather than police-reported incidents and records of alcohol outlets.

Weitzman and colleagues explored the association between counts of liquor outlets within two miles of eight US colleges and students' drinking levels [320]. Using data from a previous college alcohol survey, the authors demonstrated the correlation of total outlet density with self-reported frequent drinking, heavy episodic drinking, and drinking-related problems. The correlations between drinking and outlet density were particularly strong for women and students who first started binge drinking at college.

In a Californian telephone survey study, Treno and colleagues explored the associations between outlet density and driving after drinking (DAD), and with riding with drinking drivers (RWDD) in 15 to 20 year-olds [321]. The authors indicated that, as anticipated, higher alcohol outlet density (a city-level predictor) was associated with more frequent DAD and RWDD. These associations were stronger among females and younger participants. However, only 20% of the variability in DAD-behaviour was explained by city-level predictors (outlet density), with the remainder explained by individual-level factors (age, gender and ethnicity). Despite this, the authors felt that controlling outlet density would be a viable method of reducing drink driving as (unlike individual-level characteristics) outlet density is easily regulated by alcohol policy.

Because of minimum drinking-age laws, many adolescents rely on social sources of alcohol such as older friends, siblings or parents, a reliance representing the social availability of alcohol [322, 323]. Therefore, traditional measures of physical availability may not adequately reflect access to alcohol. To account for this, several studies of drinking in young people have included measures of both outlet density and social availability, and have explored how the two interact.

For three consecutive years, Chen and colleagues surveyed the same group of 1,091 adolescents on their drinking habits [21, 324]. The authors showed that both commercial and social access were associated with higher outlet density. Adolescents living in areas with high outlet density had higher initial levels of drinking and excessive drinking than those living in lower outlet density areas. However, drinking rates grew faster among adolescents who resided in areas with lower outlet density. Access via commercial outlets accounted for a relatively small proportion of alcohol usage among adolescents (less than 5%, rising to 11% by the third wave of interviews). Alcohol was largely accessed through social networks, including family, under- and similar-aged friends. Higher alcohol outlet density increased under-age drinkers' access to alcohol indirectly, through increased availability to their social networks (their primary source of alcohol) [285]. Having a friend with access to a car was an important mediator between outlet density and consumption.

A number of studies of adolescent drinking have focused on how 'formal access' (including outlet density), 'informal access' and perceived availability of alcohol are interrelated [276, 325]. Treno and colleagues examined the effects of actual and perceived access to formal and informal sources of alcohol among American 14 to 16 year olds [276]. ‘Formal access’ was defined as direct access to alcohol through outlets. ‘Informal access’ was defined as indirect access to alcohol through parents and friends. Telephone interviews were conducted among adolescents across 30 postcodes. Each respondent’s place of residence was plotted and a two-mile buffer was created around it. The number of outlets within this area was then counted to create a measure of availability. The study revealed that access to alcohol in this age-group was largely through informal sources, and that this access was negatively associated with outlet density. However both perceived and actual access to formal sources were positively associated with off-premise density. The study suggested that, in this age-group, restrictions on formal sources of alcohol could increase reliance on informal sources.

Kuntsche et al. used survey data on a group of Swiss adolescents of a similar age to compare perceived and physical availability, and their association with drinking levels [325]. The authors established that higher perceived availability of beer, wine and spirits was associated with the following predictors: drinking in a public place, poor parental knowledge of the adolescents’ whereabouts, and peers and siblings who drank. A significant association between perceived (subjective) availability and on-premise, but not off-premise, density was evident. This might be because alcohol is visibly consumed at on-premise outlets while alcohol purchased at off-premise outlets is usually consumed elsewhere.

A recent study by Stanley and colleagues recruited a large sample of adolescents (grades 7 to 12) across the USA [326]. It investigated the interactions among physical availability (bar and liquor store outlet density), social availability (alcohol from social and family networks) and perceived availability at individual and at community-level. The study found that, while bar and liquor outlet density was not associated with perceived availability or alcohol use, social availability was strongly associated with alcohol use in the last month. The study emphasised the greater influence of social (rather than physical) availability on under-age drinkers.

In a study using a similar methodology to their earlier study [283], Truong and Sturm analysed individual demographic information and drinking behaviour among adolescents. Buffer zones were created at 0.1, 0.5, 1 and 2 miles around the place of residence of each participant [327]. Alcohol outlets were mapped and then counted for each buffer zone. The study found that participants in the lowest income quartile lived in areas with the highest counts of outlets near their homes. Adolescents with the highest count of outlets within ‘easy walking distance’ (within 0.5 miles of home) had the highest rates of binge drinking and drinking after driving.

Huckle and colleagues investigated the drinking patterns and predictors of consumption of young people aged 12 to 17 living in Auckland, New Zealand [328]. The study used both individual-level data and environmental data (socio-economic status and alcohol outlet density) and explored both the social and physical availability of alcohol to those under the minimum drinking age. Social availability (measured by the frequency that alcohol was supplied by parents and friends) was significantly associated with usual occasion drinking levels and annual drinking frequency, as well as frequency of feeling drunk. Alcohol outlet density was significantly associated with usual occasion levels of drinking, while its association with frequency of feeling drunk approached significance.

Kypri and colleagues conducted a study of six New Zealand university campuses, using a combination of individual-level data and alcohol availability data [277]. The study used a similar methodology and analysis to the study by Weitzman of college students in the USA [320]. Unlike the previous New Zealand study by Huckle and colleagues [328], alcohol-related harms, rather than drinking levels, were the outcome of interest in Kypri and colleagues’ study. Significant associations were shown to exist among both on- and off-premise outlet density, measures of consumption and personal problems because of alcohol. The associations of problem drinking with counts of outlets within 1km of residences, and with off-premise outlets, were of the greatest magnitude.

Pasch and colleagues examined alcohol availability and drinking patterns among 242 high school students in a major metropolitan area of Minnesota, USA [329]. Several measures of alcohol availability were used, including straight-line and road-network distance from place of residence and school to the nearest alcohol outlet, and the number of outlets within 3km straight-line and road-network buffers from home and school. Significant associations were not demonstrated between the measures of alcohol availability and alcohol use or drunkenness in the last month. This might have been because both the prevalence of alcohol use by the students and measures of alcohol availability were low. This would bias measures of effect downwards [329]. In addition, the sample contained a high proportion of white, middle-class, suburban pupils, which limited the potential to generalise the results.

A longitudinal study explored the impact of various factors affecting access to alcohol among urban adolescents aged 11 to 14 years from ethnic minority (Hispanic and

African American) groups [330]. The factors investigated included alcohol advertising, home access to alcohol, parental monitoring, off-premise outlet density, and commercial access. The study found a significant association between alcohol use and home alcohol access (an aspect of social availability). However, off-premise outlet density was not associated with home access to alcohol.

In their study of college students at 32 American campuses, Scribner and colleagues used multi-level modelling to differentiate between correlational (grouping by individual-level drinking patterns) and contextual (such as outlet density) effects on students' drinking levels [208]. The authors demonstrated strong positive associations among on-premise outlet density and frequency of drinking, mean and maximum drinks per occasion, and frequency of drunkenness. Contextual factors at campus-level, particularly off-campus on-premise outlet density, explained 57 to 71% per cent of variance in this study. The association between off-premise density and drinking levels was not significant.

Gruenewald and colleagues used hospital discharge data to assess how population and place (including alcohol outlet density) were associated with alcohol-related harm in two groups of young people: youth, aged 18 to 20, and young adults, aged 21 to 29 [331]. Among under-age youth, off-premise outlet density, but not on-premise outlet density, was positively associated with assault, road crashes and other accidents. Under-age youth might have had readier access to alcohol themselves or through social networks at off-premise outlets, while on-premise outlets might have been more reluctant to serve alcohol to under-age youth. Among the young adults, higher off-premise and pub densities were associated with higher assault rates, while increased restaurant density was associated with additional traffic injuries. The latter findings are similar to those in studies of adults of all ages [207, 294].

Instead of analysing the association between individual drinking patterns and outlet density, Reboussin et al. used alternating logistic regression to assess clustering of drinking within census tracts, that is, the odds of a youth (14 to 20 years old) drinking if another youth in the same census tract reported drinking [285]. The analysis indicated that, in the highest tertile of on-premise outlet density, the odds of a youth engaging in frequent drinking were more than doubled if another youth in the census tract also drank frequently. The highest tertile of off-premise outlet density was associated with the clustering of riding with drinking drivers, attempts at purchasing alcohol, and successful alcohol purchases.

A study of alcohol outlet density and youth investigated the association between off-premise outlet density and youth homicide offenders [332]. The pooled panel models (using 23 years of data across 91 large cities) revealed a significant positive association between off-premise outlet density and youth homicide rates, both for 13 to 17 year olds, and for 18 to 24 year olds (independent of measures of structural disadvantage, drug activity, firearm availability and gang influence). The models suggested that outlet density had a greater influence on homicide rates in the older group.

A recent study by Maimon and Browning used hierarchical generalised linear models to explore the relationship between under-age drinking, neighbourhood collective efficacy and alcohol sales at census block level in Chicago, USA, for 1,135 adolescents [216]. The study demonstrated that, for one standard deviation increase in sales, there was a 25% increase in under-age drinking. The measures of alcohol outlets and sales were based on videotaped observations of outlets located in face blocks, rather than official records of outlet licences and wholesale or retail sales data.

Paschall and colleagues conducted a city-level study of 50 mid-sized Californian cities in the USA [333]. Multi-level linear regression models were used to assess the association of local alcohol-control policies with enforcement funding, alcohol outlet density, adult drinking levels, and adolescent under-age drinking, perceptions of availability, enforcement and acceptability. Positive associations were demonstrated between total outlet density per roadway mile and adolescent drinking. Adolescent drinking was strongly associated with both restaurant density and bar density, but not with alcohol policy. Enforcement funding levels were negatively associated with frequency of drinking by adolescents.

A recent study in Scotland used three measures of alcohol availability: count of outlets per data zone[25], road network distance between respondents' postcodes and the nearest outlet, and the number of outlets within 1,200m (a 15-minute walk) of the respondents' postcodes [334]. Individual-level data on drinking frequency were obtained on 979 teenagers (15 year olds) in Glasgow. Drinking levels were dichotomised into weekly drinking (at least once a week) or less frequent drinking (including not drinking at all). The study found significant associations of alcohol consumption with the off-premise count within 1,200 m of the residential postcode and with the proximity of off-premise outlets, but not with off-premise density (per data zone). On-premise availability measures were not

[25] A data zone is a small census area similar to a meshblock.

significantly associated with consumption. The association between consumption and off-premise, but not on-premise outlets, may be explained by the greater ease with which under-age drinkers obtain alcohol from off-premise outlets [331, 333].

Child maltreatment

A study on the association between child maltreatment and measures of alcohol availability was undertaken at the city-level [335]. The study found a significant association between higher outlet density and higher rates of severe violence towards children; and between higher excise taxes on beer and lower rates of violence towards children. The study did not find significant associations between other measures of availability and domestic violence perpetrated on children. Data on maltreatment were based on parent-reported discipline methods: the sensitive nature of the questions entailed could have led to substantial under-reporting of maltreatment, which may have masked true associations.

Freisthler explored the associations of outlet density (separately for bar, restaurant and off-licence density), with population density, measures of ‘social disorganisation’, and child maltreatment, at census tract-level [201]. The author found an association between bar outlet density and substantiated cases of child maltreatment. Density of immigrants and poverty were also other factors associated with child maltreatment.

A subsequent study by Freisthler et al. examined two aspects of child maltreatment separately: neglect and physical abuse [206]. The study found that bar density was significantly associated with child neglect, while off-premise licence density was associated with physical abuse of children. The authors suggested that those with access to more bars were likely to spend more time at these outlets, and less time with their children. Conversely, easy access to off-premise outlets enabled the consumption of alcohol at home, with greater opportunities to physically abuse children while under the disinhibiting influence of alcohol.

Freisthler and colleagues also explored the association between child maltreatment and alcohol availability at census block group- level (a smaller geographical unit than census tracts, comparable with neighbourhoods) [336]. The association between bar density and child maltreatment was confirmed at census block group-level. In each of these three cross-sectional analyses, spatial autocorrelation and population were controlled for [201, 206, 336].

Freisthler and Weiss followed these analyses with a longitudinal study of child maltreatment [337]. The study, using Bayesian spatial models, analysed four years of county- level data on environmental factors relating to alcohol and drug use referral to child protection services, and confirmed the positive significant association between alcohol outlet density and child maltreatment.

In a more recent study of the interrelationships among outlet density, parental monitoring and adolescent deviance, Freisthler et al. used hierarchical linear modelling to incorporate both individual- and postcode-level predictors [338]. The models demonstrated that the association between parental monitoring and adolescent deviance was mediated by bar density (bars per roadway mile). Because of the previously demonstrated association between off-licence density and child neglect [206], the authors anticipated a similar association between off-licence density and parental monitoring. However, no association was found, possibly due to differences in the denominator used to calculate outlet density (roadway miles), the use of a different geographic unit (postcode-level), and a study population within a narrow age-group (14 to 16 years old).

Freisthler and Gruenewald investigated the associations between outlet density and both corporal punishment and physical abuse [339]. Both individual-level (drinking levels and location of drinking) and ecological-level (alcohol outlets within 800 m of the place of residence) predictors were included in the analysis. Controlling for frequency of drinking location and quantity of drinking at the individual-level, physical abuse was positively associated with bar density and negatively associated with restaurant density. The authors concluded that child physical abuse was associated with both individual effects (the disinhibiting effects of alcohol) and ecological effects (drinking locations).

A study by Cameron and colleagues, in Manukau City, New Zealand, examined the relationship between alcohol outlet density and multiple police-reported incidents (including family violence) [302]. Family violence was significantly associated with bar density, but not with off-premise outlet density. This contrasted with previous research by Freisthler and colleagues [201, 206]. The authors found it difficult to explain these differences. The cross-sectional nature of the study may have created misleading associations, as longitudinal studies have been shown to produce contrasting but more valid associations [340, 341].

Sexually transmitted infections

A longitudinal spatial analysis investigating gonorrhoea rates in Los Angeles, USA, was carried out at census tract-level. The study used the 1992 riots (with the resulting damage and sudden closing of multiple outlets) as the baseline level in the models. The study found that a drop in alcohol outlet density of one unit was associated with 21 fewer gonorrhoea cases per 100,000 population. Property damage was not significantly associated with gonorrhoea rates.

Domestic and intimate partner violence

An early study of the relationship between alcohol outlet density and domestic violence failed to demonstrate a significant association between the two [270]. Later studies have produced different results.

McKinney and colleagues used multi-level modelling to explore the relationship between outlet density and domestic violence at postcode-level [342]. Together with outlet density, the authors used individual-level socio-demographic and behavioural factors as predictors. The study demonstrated that an increase of 10 on-premises outlets per 10,000 persons was associated with a 30% increase in male-on-female interpersonal violence. This association was stronger among couples who reported alcohol-related problems.

Cunradi et al. undertook an ecological study of intimate partner violence (IPV), using police calls and crime reports of intimate partner violence as the outcome variables [274]. The study used small police-defined areas in the city of Sacramento, California, USA, as the unit of analysis. Bayesian space-time models, controlling for socio-economic factors, indicated that a higher off-premise density was associated with an increase in police calls and crime reports of IPV.

Following this, Cunradi and colleagues conducted a longitudinal study using Emergency Department IPV presentations as the outcome of interest [26]. Because ED presentations were used, only more severe incidents of IPV were included in the study (as those involved in less serious incidents would not present at EDs for treatment). The study was conducted at postcode-level across California, and used a Bayesian hierarchical model which allowed for changing postcode boundaries over the study period. Contrary to the previous study, the findings indicated that bar density was significantly associated with IPV. An increase in one bar per square mile resulted in a 3% increase in IPV cases presenting at EDs. Off-premise outlet density was negatively associated with ED presentations. The differences between Cunradi and colleagues' cross-sectional and longitudinal studies may be a result of different mechanisms mediating the association between density of different outlet types and varying measures of intimate partner harms [26, 274].

A recent study produced different results [343]. Waller and colleagues analysed data extracted from a cohort study of women aged 18 to 26 years old. The study included individual-level drinking patterns (frequency and amount consumed), self-reported IPV, total alcohol outlet density and both individual- and community-level socio-demographic variables and indices. None of the models demonstrated significant associations between alcohol outlet density and either self-reported IPV or individual alcohol consumption patterns. The authors suggested two explanations for these results: that the association between IPV and outlet does not act at the level of census tracts (the geographic unit of analysis in this study); or that IPV (which generally occurs in the home) is not associated with outlet density, while violence associated with outlet density (for example assault of a stranger) occurs in and around outlets. The same authors also investigated IPV affecting heterosexual males aged 18 to 26 years [344]. Significant associations were demonstrated between IPV on men and both consumption and outlet density. The hypothesised mediating effect of consumption on the outlet density/IPV pathway was not demonstrated. Cohabiting and being married were both situations associated with a significantly increased risk of IPV. Notably, both the analyses of young females and of young males who experienced IPV used a small age range, limiting the generalisability of these results.

McKinney et al. analysed an earlier (1995) survey of married or cohabiting people to explore the association of alcohol outlet density with poverty, binge drinking and alcohol-related harms [345]. While the study did demonstrate associations between alcohol outlet density and poverty, it failed to show associations between outlet density and either binge drinking or alcohol-related harms. The authors proposed that outlet density might be associated with binge drinking and harms through group-level mechanisms (e.g. clustering of like-minded drinkers at venues), rather than through individual-level factors. The authors concluded that using an ecological study design might be a more appropriate method of studying the effects of alcohol outlet density on harms.

A cross-sectional study disaggregated counts of police calls about domestic violence into weekday and weekend calls at block group-level in the District of Columbia, Canada [209]. Roman and colleagues chose to use a generalised cross-entropy approach (allowing for both under- and over-dispersion of the data, and spatial autocorrelation). The study findings demonstrated that off-premise outlet density was positively associated with domestic violence calls on weekends (but not weekdays), and that on-premise outlet density was negatively associated with calls throughout the week. While the method of measuring IPV and the cross-sectional design limited the conclusions which could be drawn from the study, it did focus on IPV calls over a time period which suggested that these calls were highly likely to be alcohol-related [168].

Suicide

A study by Markowitz and colleagues examined more than 20 years of state-level data on completed suicides in youth aged 10 to 24 years old and the associations with total population per capita alcohol consumption and alcohol control policies [289]. Higher male suicide rates were associated with higher alcohol consumption, lower beer excise taxes and higher alcohol outlet density (per population). Female suicide rates were not associated with alcohol consumption levels or outlet density. Escobedo and Ortiz (in a study of multiple alcohol-related harms discussed above) demonstrated a 50% increase in suicide rates between the first and third tertiles of outlet alcohol density [296].

A later study investigated the association between suicide and outlet density at postcode-level [346]. Both attempted and completed suicides were included, and outlet density was disaggregated into bar, restaurant and off-premise outlet density. Johnson and colleagues' analysis indicated positive associations among suicide and both local and lagged bar densities, and local off-licence density. Conversely, suicide was negatively associated with restaurant density. The authors suggest that the latter observation may be a correlational artefact in the data and also caution that this study, like Markowitz and colleagues' study [289], might be subject to ecological fallacy—that is, inferring individual behaviour from broad population-based data.

Branas and colleagues conducted a separate analysis of gun suicide [347] using data from a study on gun-related assault and alcohol availability [313]. The matched case-control study included 149 completed and attempted gun suicides, and 302 population-based controls. Multiple individual and situational variables were controlled for in the analysis. The model revealed that gun suicide and acute alcohol consumption were significantly positively associated. On-premise alcohol outlet density was negatively associated with the risk of gun suicide, while off-premise outlet density was positively, but not significantly, associated with gun suicide. The small sample size (and resulting lack of statistical power) may account for the non-significant results. The authors observed that these findings were similar to those of the study by Johnson et al. [346]. Both Branas and Johnson and colleagues commented that the differences in the observed associations with on- and off-premise outlets may be the result of the confounding effect of outlet density in the relationship between social isolation and suicide.

Other outlet density studies involving alcohol-related harms, problem drinking and socio-demographic factors

A San Diego-based study in California, USA, investigated the association between alcohol outlet density and alcohol-related hospital admissions [18]. Postcodes were used to link alcohol outlets and the place of residence of those admitted to hospital with an alcohol-related condition. The study found that an increase of one liquor licence per 10,000 population was associated with an increase of 0.48 admissions per 10,000 population. This study may have underestimated alcohol-related admissions because of the narrow definition of alcohol-related conditions (those cases with ICD-9 codes mentioning alcohol, and a small group of other conditions frequently involving alcohol, e.g. chronic pancreatitis). Conditions relating to chronic effects of alcohol were over- represented compared to acute conditions such as injuries.

A survey-based study explored the association between alcohol outlet density and injury in California and South Carolina, USA [348]. The study used self-reported injury data, resulting in the inclusion of less serious injury cases which would not have presented at an ED or been reported to the police. Associations were demonstrated between injury and both on- and off-premise outlets within 2km of the place of residence. The injuries were not necessarily alcohol-related so the association with counts of alcohol outlets may have been inflated. Demographic factors associated with injury and alcohol outlet density were younger age, male gender and Hispanic ethnicity.

Scribner and colleagues [349] demonstrated that outlet density affects alcohol consumption via a structural effect — that is, it affects everyone in a particular neighbourhood — not through an individual-level relationship as suggested by Truong and Sturm [283]. This suggests that levels of consumption are more closely related to mean distance to alcohol outlets for all residents in a neighbourhood than to individual distances to outlets for each resident. Therefore, using a central point in a neighbourhood as a ‘proxy’ of place of residence would be a viable method to measure neighbourhood distance to an alcohol outlet.

A study by Pollack and colleagues examined relationships found among neighbourhood deprivation, alcohol consumption and availability (including licensed per square mile and distance to outlets) over a 12-year period [275]. Multi-level analysis revealed outlet clustering and higher outlet density in the areas with the highest neighbourhood deprivation. However, a greater proportion of those living in areas of lower neighbourhood deprivation and higher individual socio-economic status were classified as heavy drinkers. Alcohol outlet density did not mediate the relationship between neighbourhood deprivation and high alcohol consumption. Since the study did not examine alcohol-related harms, the possibility of a direct relationship between outlet density and alcohol-related harms (independent of consumption levels) could not be explored. Alcohol consumption was measured dichotomously as 'high' or 'low', based on pre-set cut-off points[26] chosen because of the increased risk of mortality associated with them [350]. However, these measures were more appropriate to the study of chronic alcohol-related morbidity and mortality. Patterns of drinking (quantity and frequency), more relevant when examining acute harms such as injury, were not examined. The measures used could have masked the role of outlet density in mediating the relationship between neighbourhood deprivation and patterns of consumption associated with acute harm.

The relationships among outlet density and race, age and income discussed by Pollack [275] and Gyimah-Brempong [303, 305] were further explored by Romley et al. [287]. The analysis confirmed that minority groups tend to live in postcodes with significantly higher liquor store density. Minorities living in lower income postcodes were exposed to higher liquor store density than others, and minority youth were exposed to higher liquor store outlet density than white youth. The associations between socio-demographic factors and outlet density varied according to the definition of outlet density.

Several measures of alcohol availability and their relationship to socio-demographic factors were explored in a study conducted in two different regions of the USA (Los Angeles County and southern Louisiana) [351]. The authors argued that traditional measures of availability such as outlet density do not account for differences in the size of outlets, relative availability of different beverage types and differences in promotions or prices. The study therefore used alternative measures of alcohol availability, including the number of alcohol outlets per roadway mile, shelf

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[26] >7 and >14 drinks per week for females and males respectively.

space (linear length) per beverage type per outlet, and minimum price per beverage type per outlet. Each outlet was examined and categorised according to these measures of availability. Analysis showed that larger shelf space occupied by malt liquor[27] was associated with lower socio-economic status and a lower proportion of white population, while more beer shelf space was associated with higher socio-economic status. Higher distilled spirits shelf space was associated with lower male unemployment. The results suggested differential availability according to socio-economic status and ethnic group. Minimum price per beverage was not associated with any community measures.

3.7.5 Studies in Australia

Initial Australian studies into the impact of alcohol outlets focused on drink driving. These studies were undertaken by Stockwell and colleagues in the 1990s, in Perth, WA.

A study conducted by Lang and Stockwell compared alcohol-involved collisions and drink drivers who were not involved in collisions [352]. Data was collected on the place of last drinking and other environmental factors, including time of day and day of the week. Young males and those with higher BACs were over-represented in alcohol-related collisions. Most of these collisions occurred at night or in the early hours of the morning.

Stockwell and colleagues also explored how the type of alcohol licence was associated with alcohol-related harms by using Perth police data on drink driving and collisions after drinking [205]. The study included assaults around licensed premises and controlled for alcohol sales per outlet. The study found that nightclubs, taverns and hotels were higher risk venues for assault, driving after drinking and alcohol-related crashes that occurred after attending the venues. The authors suggested that licence conditions, hours of sale and the type of clients who patronised venues with different licence types could explain these findings. These results were complemented by a household survey of 1,160 residents of the Perth Metropolitan Area [353]. Data were collected on harmful drinking, the type of harms, and the characteristics of the venues frequented. The significant association between hotels and nightclubs and alcohol-related harm was reproduced in the survey.

Research since 2000 has focused specifically on alcohol outlet density, consumption levels and alcohol-related harm. A range of cross-sectional and longitudinal studies into the association between alcohol outlet density and harms has been conducted in WA, NSW and Victoria.

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[27] Malt liquor, in North America, refers to a type of beer with a high alcohol content (>5%).

Donnelly and colleagues at the New South Wales Bureau of Crime Statistics and Research (BOSCAR) undertook a local study using survey data from more than 9,300 participants [80]. The analysis used two measures of alcohol availability: alcohol outlet density (per 10,000 population per Statistical Local Area), and alcohol outlet accessibility (the average distance to the five outlets closest to the place of residence). The associations of these measures of alcohol availability with self-reported neighbourhood property damage, drunkenness, and personal assault were estimated. Those who lived closer to alcohol outlets reported significantly more problems with drunkenness and property damage in their neighbourhoods (that is, negative amenity effects). Those living in areas with higher alcohol outlet densities per 10,000 population reported significantly more neighbourhood drunkenness but not more property damage. Because of the small number of reported domestic assaults and lack of statistical power, the relationship between assault and alcohol availability could not be successfully modelled.

Livingston conducted a series of analyses on police records of assault using data from Melbourne, Victoria [15, 240, 354]. A cross-sectional study used several models to investigate: linear and non-linear relationships between assault and outlet density, the interaction between outlet density and socio-economic status, and spatial lag effects. The author demonstrated a non-linear relationship between assault and general outlet density [240]. The study suggested that rates of violence accelerated when hotel densities reached a threshold level. This finding could enable the setting of upper limits for hotel licence densities in the Melbourne area. The relationship between on-premise outlet density and assault was linear, showing no clear threshold beyond which the assault rate accelerated.

Livingston used nine years of postcode-level data to demonstrate a significant positive association between alcohol outlet density and assault [15]. Five clusters, each containing postcodes with similar socio-demographic profiles, were created in the greater Melbourne area. In four of the five clusters, significant associations were demonstrated between outlet density and assault; the outlet type associated with assault varied from cluster to cluster. For example, hotel licences were strongly associated with assault in the inner city, while packaged liquor (off-premise) outlets were more strongly associated with assault in the suburban areas of Melbourne. Collapsing the postcodes of Melbourne into five clusters limited the ability of the study to explore the complexity of the relationship between where people live and buy alcohol. In addition, as the author stated, the study was unable to distinguish among different outlets with the same licence but with varying sizes, trading hours and volumes of sales.

In a cross-sectional postcode-level analysis based in Melbourne, Livingston examined the association between domestic violence (police-reported ‘family incidents’ including children, parents and couples) and outlet density [340]. A model which included outlet density as a predictor explained 9% of the variance in domestic violence. Adding socio-demographic variables enabled the model to explain 55% of the variance in domestic violence. The final models, which corrected for spatial dependence, indicated that an increase of one general licence per 1,000 population was associated with 1.35 more incidents of reported domestic violence. An increase of one on-premise outlet per 1,000 population was associated with 0.34 fewer incidents of domestic violence. Surprisingly, packaged (off-premise) outlet density was not associated with domestic violence rates.

In a follow-up to this cross-sectional study, Livingston analysed 10 years of data on police-reported ‘household incidents’ [341]. Although it used similar data sources, geographic units and statistical models to the cross-sectional study, the longitudinal study produced different findings. The results suggested that, while there were positive associations between domestic violence and both general and on-premise alcohol outlet density, there was a stronger association between domestic violence and off-premise outlet density. When all three licence types were included in the model, only off-premise outlet density remained significantly associated with domestic violence. An increase of one off-premise outlet per 1,000 population was associated with an increase of 0.66 domestic violence incidents.

The same author examined hospital admissions for assaults which involved alcohol [355]. Chronic alcohol-related harms (admissions for wholly alcohol-caused diagnoses) were a further outcome variable. Livingston hypothesised that on-premise alcohol outlet density would be associated with violence, and off-premise alcohol outlet density would be associated with chronic harms (because higher densities of off-premise outlets would be associated with lower prices). These hypotheses were supported by the analyses. However, there were some unexpected significant associations: off-premise density was positively associated with violence (which could reflect incidents of domestic violence being associated with intoxication in the home), and on-premise licence density was associated with chronic disease.

An analysis of the Sydney Local Government Area (LGA) explored the association between alcohol outlet density and assault [288]. Burgess and Moffatt calculated the counts of police-reported assault at various buffers around licensed outlets, and then compared these to counts of assault around non-licensed commercial premises. Buffer zones, rather than administrative units such as a postcode or LGA, were the geographic units of analysis. This avoided biases that could have been caused by the Modifiable Areal Unit Problem (MAUP). The study demonstrated that nearly 93% of assaults in the Sydney LGA occurred within 200m of a licensed outlet, and that over 50% of assaults occurred within 50m of a licensed premise. More assaults occurred in the buffers around licensed premises than around non-licensed commercial premises. The authors calculated that each additional licensed outlet per hectare was associated with 4.5 additional assaults per year. The study only used data from the Sydney LGA (the central business district—CBD—and main entertainment district) making the results very specific to this area and difficult to generalise to the rest of Sydney or even other CBDs in major Australian cities.

A Melbourne-based study used census collector districts (a small geographic unit) to assess the association between alcohol outlet density and harmful drinking [356]. Two measures of availability were used: alcohol outlet density (the number of outlets within a 1km road trip from the place of residence), and alcohol outlet proximity (the shortest road network distance from the place of residence to nearest outlet). Individual-level survey data was used to identify those participants who drank at levels that risked short- and long-term harm (according to the Australian Drinking Guidelines [357]). Kavanagh and colleagues found that outlet density was significantly associated with drinking at levels risking short-term harm. The analysis found that the threshold risk of short-term harmful drinking occurred when eight or more outlets were situated within a 1km road trip from the place of residence. Alcohol outlet proximity was not significantly associated with harmful drinking. This study did not control for spatial autocorrelation, which may have biased the results.

A population survey by Wilkinson and Livingston used ‘amenity problems’ as a measure of alcohol-related harm [291]. Participants were questioned about the distance from their homes to their nearest on- and off-premise alcohol outlets, and then asked if they had experienced amenity problems caused by alcohol use by strangers. Amenity problems were defined as being kept awake or disturbed at night, feeling unsafe in a public place, avoiding drunken people, property damage, and urination or vomiting. Using multivariate logistic regression (and controlling for socio-economic status and demographic factors), the association between each measure and distance to the nearest outlet was explored. The analysis showed that for every 1km that their home was distant from the nearest club or pub, participants were 4% less likely to experience disturbed sleep. Similarly, for every 1km that their home was distant from the nearest bottle shop, participants were 7% less likely to experience property damage. Limitations of the study included not testing for the reliability and validity of the measures of amenity used in the study, and the questionable accuracy of using self-reported distances to outlets.

A Perth-based study explored the association between counts of off-premise outlets within 1,600m of place of residence and mental health problems [358]. Using data from the Western Australian Health and Wellbeing Surveillance System surveys from 2006—2009, the authors gained permission from 73% of participants to link their survey results to data[28] on place of residence and hospital admissions for anxiety, depression and stress. Pereira and colleagues found a significant positive association between the number of liquor stores within 1,600m of a residence and harmful consumption of alcohol within the past four weeks (as defined by the National Drinking Guidelines) (OR=1.06; 95% CI: 1.02–1.22). When at least one off-premise outlet was located within 1,600m of the residence, there was a 56% increase in the odds of a mental health hospital contact (but this was not significant: 95% CI: 0.98–2.49).

In summary, reviews of the outlet density literature have noted that research has consistently demonstrated associations between outlet density and violence (domestic violence and assault), across varying geographical regions, study designs and units of analysis [29, 41, 84, 218, 221]. Research into effects on road safety have produced mixed results [11, 249, 267, 299]. Studies of drinking in both under-age and drinking-age youth suggest that social availability is a more important influence on consumption and harm levels in young people than physical availability [208, 321, 324]. To date, the independent relationships between on- and off-premise outlets and alcohol-related harms have been more difficult to elicit. Some studies have demonstrated associations between alcohol-related harms and off-premise outlets only [206, 286], or stronger associations with off-premise compared to on-premise outlets [277]. In contrast, other studies have found the associations between on- and off-premise outlets to be of similar magnitude [16, 19, 348].

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[28] Data on mental health admissions were stored by the Western Australian Data Linkage System.

3.8 Evidence for associations between alcohol sales and harm

A general limitation of previous research is that few studies have incorporated reliable measures of actual alcohol sales made by licensed outlets. Most studies have therefore been unable to account for variations among outlets (and regions) in relation to their capacity to influence levels of alcohol consumption within a community. For example, a discount warehouse liquor outlet with large sales of various types of alcohol would be given the same weighting as a specialty wine store with much smaller sales.

Furthermore, the relationship between availability and consumption remains contentious. Studies discussed above (3.7.2) by Wilkinson [256] and Godfrey[257] provided evidence suggestive of a simultaneous relationship between consumption and availability. A study by Gruenewald and colleagues, using panel data, demonstrated a direct relationship between outlet density and sales of spirits and wine. The authors concluded that sales of spirits and beer *"place[d] consistent upward pressure"* on outlet density [253]. When examining the association between alcohol outlet density and cirrhosis mortality, Xie et al. found that outlet density was both directly and indirectly associated with cirrhosis mortality [359]. The indirect relationship was via alcohol consumption (sales per capita). Higher outlet density was associated with higher consumption, which in turn was associated with cirrhosis mortality.

A further study, examining mean daily consumption of alcohol, was conducted in two regions of the USA (Los Angeles County and southern Louisiana). Three measures of availability were used: distance from the place of residence to the nearest off-premise outlet, number of off-premise outlets per buffer zone around the residence, and outlets per residential census tract [360]. Alcohol outlet density was not associated with the drinking status of respondents. Consumption was, however, associated with the number of outlets within a one-mile buffer of residence in southern Louisiana. However, no relationship was demonstrated between consumption and outlet density in Los Angeles County. These results could have been partly because of the definition of 'alcohol consumption' as mean daily consumption, rather than measuring drinking patterns (frequency and quantity per occasion); or because of the greater propensity of residents of Los Angeles County to travel to purchase alcohol.

Picone and colleagues investigated the associations between consumption levels and outlet density measured in zones: less than 0.5km, 0.5 to 1km and 1km to 2km from the place of residence [361]. Consumption levels were significantly associated with outlet density within a 0.5km radius of the place of residence. However, the effect size was small (an increase of one bar led to an increase of 0.32ml of alcohol consumed per day) and became insignificant when person-specific fixed effects were included in the model.

A limited number of studies have been undertaken internationally and in Australia using sales data. Many of them have analysed data at state or even country-level, increasing the risk of ecological fallacy.

3.8.1 International studies

Gruenewald and Ponicki conducted analyses of 12 years of data pertaining to cirrhosis mortality, suicide and single-vehicle night-time crashes (as a surrogate for alcohol-involved road crashes) [267, 362, 363]. The authors analysed panel data (at state-level) using retail sales of beer, wine and spirits. The analysis used least-squares dummy variables, thereby avoiding biased coefficient estimates (present in some earlier studies that used ordinary least-square regression). More sophisticated controls were used to account for variations in land area and tourism [362]. Significant associations were shown between sales of beer and single-vehicle night-time crashes [267], and between sales of spirits and both suicide [363] and cirrhosis mortality [362].

An association between full-strength beer and alcohol-related harms and risky behaviours has been demonstrated in other studies [20, 29, 364]. Gruenewald argued that beer drinking and drink-driving were not directly associated, but that the two behaviours shared common socio-demographic and situational factors such as younger age, male gender, lower education and income, and similar drinking venue (bars) [20].

A more recent Canadian study used a population-based case-crossover design to examine the association between alcohol sales and assault [365]. Using all hospitalised assaults as cases (identified using ICD-10 codes for external causes), data was gathered on volumes of alcohol sales at the closest state-controlled off-premise outlet on the day of assault (case stage) and seven days earlier (control stage). Conditional logistic regression models demonstrated that the risk of hospitalisation for assault increased with higher alcohol sales at the outlet nearest the victim’s place of residence. With an additional 1,000 litres of alcohol sold per store per day, the risk of hospitalisation for assault rose by 13% (95% CI: 2%–26%). This risk of assault was highest for sales of spirits (OR = 1.26; 95% CI: 1.02–1.55). The study used a stronger design than previous studies of alcohol sales and complemented both ED and outlet density studies on violence and alcohol. However, the study was limited by the exclusion of less severe assaults (that is, assaults which did not result in hospitalisation), and the assumption that all assaults were alcohol-related.

Norström and Razvodovsky examined 35 years of data on alcohol sales per capita and measures of male mortality and morbidity in the Republic of Belarus, Eastern Europe (formerly a constituent part of the Soviet Union) [366]. Female total mortality and cigarette sales were used as controls. The results showed that an 11% increase in per capita consumption was associated with a 2.3% increase in male mortality. The similar trend between alcohol-related mortality and morbidity and alcohol sales per capita continued until the mid- to late 1980s, after which harms increased at a higher rate than per capita sales. The authors suggested that this may have been because of the increase in unrecorded alcohol consumption that accompanied the disintegration of the Soviet Union (finalised in 1991).

Kerr and colleagues examined more than 50 years of state-level sales data in the USA [367]. The authors investigated the associations among per capita alcohol and cigarette sales, ischaemic heart disease (IHD) and cirrhosis mortality. Like the Belarusian study, the study used large geographic units (states) with no individual- or community-level controls. The study separately investigated the effects of specific beverage types on IHD, demonstrating a significant negative association between IHD and beer, and a significant positive association with spirits. Overall, the authors found that an increase of one litre of pure alcohol consumed was associated with an increase of 1% in IHD rates.

3.8.2 Australian studies

Researchers in WA have investigated the relationship between licensed premises and harm in Perth [205, 352, 353, 368]. Alcohol purchases by licensed premises were included in the analyses. The studies demonstrated that assault near a licensed premise, driving-after-drinking offences, and alcohol-related road crashes were all significantly correlated with adjusted annual alcohol purchases at hotels and taverns [368]. Driving after drinking was most highly correlated with annual alcohol purchases. Furthermore, there was a stronger correlation between high-strength alcohol sales and the measured harms, than between low-strength alcohol sales and harms.

The Measurement of Alcohol for Public Policy (MAPP) consortium[29], based in WA, was established to analyse and present the available alcohol data in a format which would facilitate harm-prevention planning [370]. The initial report comprised data on per capita alcohol consumption (estimated using wholesale sales of alcohol); socio-demographic data from the Australian Bureau of Statistics (ABS); and measures of harm including assault, drink driving, road crashes and morbidity across 130 local government areas of WA [28]. The study found significant correlations between per capita alcohol consumption and all harms. The authors noted that the most sensitive indicator of harm was night-time presentations, and suggested exploring this further, particularly with regard to ED injury presentations (see later research to develop an ED surrogate measure by the NDRI in 3.4.6) [371]. Further findings in this study included strong positive associations between consumption of wine or high-strength beer, and levels of harm.

A MAPP study published in 1998 used GIS to examine the association between alcohol sales and injury across five regions representing the whole of WA [370]. Data sources included alcohol purchases by wholesalers, a 1995 health survey, census data, and records of alcohol-related harms (police-reported assault, road crashes and hospital morbidity). The study demonstrated that hospital E-code morbidity and per capita alcohol consumption were perfectly correlated, and that night-time assault and alcohol consumption were also strongly correlated. However, minor night-time crashes[30] and alcohol consumption were weakly correlated. The authors argued that the latter finding was due to regional population and socio-economic differences across the study area. A further study by the MAPP consortium examined the impact of alcohol sales of different beverage types (low-alcohol beer, regular beer, low-alcohol wine, regular wine and spirits) on rates of night-time assault and hospital morbidity in 130 areas of WA [169]. The study found that sales of high-strength beer and cask wine were significantly positively associated with night-time assault and hospital morbidity. Moreover, areas with a high proportion of low-strength beer sales had lower rates of acute alcohol-related mortality.

Gruenewald, Stockwell and colleagues studied the association between driving after drinking and beverage-specific sales at Perth on-premise alcohol outlets over a four-year period [364]. The authors demonstrated a higher risk of drink driving at premises selling

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[29] The project included the National Centre for Research into the Prevention of Drug Abuse (now known as the National Drug Research Institute [369]) at Curtin University as well as other university departments, the Health Department of WA, alcohol and road safety organisations. The consortium produced publications relating to wholesale purchases of alcohol and alcohol-related harms [29].

[30] Minor night-time crashes were defined as crashes that did not involve hospitalisation or death.

higher proportions of beer and spirits and lower proportions of wine. Sales at cabarets and venues that sold larger proportions of regular-strength beer were associated with greater numbers of drinking drivers.

Stevenson and colleagues examined the relationship between alcohol sales assault [23] and anti-social behaviour [372] in metropolitan Sydney and country study found that, when alcohol outlet density was controlled for, alcohol sales in were associated with assault [23]. Over 28% of the variability in assault rates was accounted for by alcohol sales. Hotel and restaurant sales were independently significantly associated with assault. In country NSW, a significant association was demonstrated between alcohol sales and assault, with sales accounting for just over 5% of the variability in assault. Most of this variability was explained by sales at hotels and off-premise outlets. However, alcohol outlet density was not significantly associated with assault. The second analysis explored the associations of alcohol sales with offensive behaviour and malicious damage to property in the same regions [372]. Both outcomes were significantly associated with alcohol sales, in both Sydney and country NSW. However, in the Sydney analysis, total sales accounted for more of the variability in assault than in the country NSW models. The differences between associations in metropolitan and country areas highlight the varying mechanisms and degrees by which outlet density and sales influence harm across different geographical areas. The use of LGAs as the unit of analysis may account for these differences: LGAs in regional areas are geographically larger and more diverse than those in the metropolitan area.

The NDRI undertook a feasibility study exploring different measures of alcohol-related harms in WA [29]. Chikritzhs and colleagues used three measures of alcohol availability: count of outlets in each LGA, count of outlets divided by total land area in the LGA, and volume of wholesale alcohol purchases made by retail outlets. The study demonstrated that the volume of regular-strength beer was consistently positively associated with alcohol-related morbidity and mortality, assault, and positive drink-driving breath tests. The association was strongest between regular-strength beer and assault.

Recent research has investigated relationships among average alcohol sales, number and type of outlets (i.e. on- and off-premise outlets), and police-reported assaults in Western Australian LGAs [22]. The cross-sectional study demonstrated that counts of outlets, rather than alcohol sales, predicted assaults at on-premise outlets. In contrast, sales were significant predictors of assault at off-premise outlets. An increase of 10,000 litres of alcohol sales at off-premise outlets was associated with a 26% increase in the risk of assault at residential premises. Counts of off-premise outlets were not associated with assault rates in WA. Counts of assaults were then disaggregated by venue (on-premise outlets, private residences and other places). Alcohol sales at off-premise outlets strongly predicted violence at both private residences and on-premise outlets. The authors propose that the latter association may operate through pre-loading, that is, the drinking of alcohol bought at an off-premise outlet before entering an on-premise outlet. The authors suggest that off-premise outlets and harms may be associated via the proximity effect [218], while the association between on-premise outlets and harms may be a result of the amenity effect.

In summary, there is considerably less literature available on the associations between sales and alcohol-related harms, and the methods used varied. This study drew particularly on the studies in Western Australia to inform the methods. This is discussed further in Section 3.9.1.

3.9 Methodological issues relating to analysis of data in the current project

3.9.1 The use of wholesale alcohol purchases by outlets as a proxy for retail sales of alcohol

There are two major tools for estimating alcohol consumption in the population: survey data or sales data [165]. While surveys provide useful information for policy decisions and estimation, they tend to underestimate per capita consumption [165] by up to 60% [373]. Furthermore, survey data cannot be used when complete records of alcohol volumes are required for each geographic unit in the study area.

Sales data may be obtained from taxation records, wholesale or retail purchase records [165]. Taxation records and wholesale alcohol sales are less accurate than retail sales: alcohol sold by wholesalers in one year may be consumed in another year (e.g. because of stockpiling if a taxation increase is expected), and some wastage and breakage can occur before the alcohol is sold to the consumer [22]. However, even retail sales data have limitations, as retail records exclude mail order and internet purchases (although these are estimated to account for less than 2% of purchases)[239], home brewing and illegal distillation [372], and cannot account for wine which is collected over years by retail purchasers. Retail sales data have been used by researchers in the USA and Canada [257, 267, 359, 365].

Alcohol researchers in Australia have used readily available wholesale data [22, 23, 29]. Wholesale purchases by alcohol outlets are considered a satisfactory proxy for retail sales [374]. Up until 1996, liquor licensing authorities across Australia collected alcohol sales data. These data were electronically available from 1990 to 1996 [375]. In 1997, the Federal High Court ruled that state governments were not allowed to levy alcohol taxes (only the federal government was permitted to do this), removing the incentive for states and territories to collect sales data. Only the NT and WA, and later Queensland, have continued to collect this data. As a result, a valuable method of monitoring per capita consumption and evaluating alcohol policy has been removed in the other states and territory [375, 376]. The ABS continues to estimate national-level per capita consumption, basing its calculations on import clearance, excise and available sales data [375].

3.9.2 The use of buffer zones in outlet density literature

As discussed above, alcohol outlet density is a measure of physical availability which is calculated by dividing the count of outlets by either population or a measure of place (area, roadway distance, squared roadway distance, or geographic unit) [29]. Outlet density can be misleading when a large geographic unit has a very small population (which may be clustered in one part of the area or scattered throughout the area); if one geographic unit has a much larger population (such as a densely packed residential area) than other units of a similar size in the study region [283], and if a geographic unit has a large mobile population. An entertainment district, for example, may have a small residential population but a large population of 'visitors' (tourists or residents from surrounding areas attending outlets in the area).

Measures of outlet density can be influenced by the size of the geographic unit. These geographic units may be artificial administrative units (e.g. postcodes or census tracts), which do not necessarily reflect geographical features of the area, such as rivers, roads or bridges. Geographic units do not account for how people interact with their environment through transport routes and community facilities. Modifiable Areal Unit Problem (MAUP) can occur in analyses involving administrative boundaries. MAUP is defined as a situation where: *"...relationships between geographically continuous variables change with the imposition of arbitrary artificial boundaries. It can lead to misleading research findings because crime and alcohol outlet density is a function of the size, shape and orientation of the administrative boundaries being used."* (p. 3 [288]).

Using buffer zones to analyse the associations between alcohol outlets and alcohol-related harms can overcome the difficulties which can occur with outlet density and the problem of MAUP. Murray and Roncek describe buffer zones as: *"…the creation of a type of frame around a particular object on a map. This frame, or buffer, can be easily and accurately created through software designed to frame objects in any shape or size"* (p. 201 [220]).

Instead of administrative units such as postcodes or LGAs, buffer zones can act as the geographic units of analysis [288]. Buffer zones were initially used in criminological research, beginning with Shaw and McKay's 1942 paper on juvenile delinquency [220]. Later criminology studies used buffer zones to investigate the 'displacement' (or 'relocation diffusion') of crime [220]. This concept explores how crime moves from one area to another, and is applicable to alcohol availability research where crimes such as assault and homicide are the outcomes of interest. For example, police enforcement at the initial crime 'hotspot' may result in the hotspot moving to another area. Because of the presence of 'guardians' such as bouncers or fellow patrons at bars (see discussion of routine activities theory in 3.5.2), alcohol-related assaults may 'displace' from bars [220]. For the purposes of analysis, these assaults can be linked to the outlets through buffers constructed around the outlets.

Buffers are most commonly concentric (radial buffers), but may be any shape (symmetrical or asymmetrical) if this better approximates the interaction between the central point and features within the buffer. A radial or circular buffer may not reflect the nature of displacement of the crime accurately as it may not match the topography of the geographic area [220]. Circular buffers are, however, consistent and easily reproducible by GIS software and so useful in research [377]. Murray and Roncek caution that using circular buffers alone can result in artificial and misleading results (as a buffer may run through the middle of a house or road) [220]. These authors argue that radial buffers should be used together with other methods of assessing proximity or adjacency.

Previous alcohol availability studies have created circular buffer zones around three types of point 'objects' on a GIS:

- Around alcohol outlets (where the location of each incident of alcohol-related harm, for example police-reported assaults or road crashes, is known).
- Around the actual place of residence (in multi-level studies that collect individual-level survey data).

- Around the centroid of the unit of geographic area used in the study (where the address of the residence is not known, but the geographic area, for example, postcode or meshblock, is available).

A Sydney-based study created a GIS, constructing buffer zones around outlets (ranging in size from 20—200 metres) to establish a geographic link between outlets and reported assaults [288]. The authors also used buffers around commercial premises (e.g. offices and retail outlets) and random points to compare the number and density of assaults around licensed premises, commercial areas and randomly selected points.

Place of residence is the most commonly used central feature in alcohol availability studies employing buffer zones. Buffers around the place of residence are used to establish the number of outlets within a certain distance from homes (that is, proximity). The count of outlets has been associated with alcohol consumption [275, 334, 360, 361], and problem drinking [283], rather than alcohol-related harms. A Melbourne-based study in Australia used buffers around place of residence to assess associations with risk of harmful drinking [356].

Other studies have used buffer zones around places of residence and college campuses to assess the impact of outlet density on drinking among under-age drinkers and college students [208, 276, 327, 329]. These studies have created buffer zones ranging from 0.1 to 1 mile, using the count of outlets in each buffer zone as a measure of availability. Pollack and colleagues classified areas dichotomously as having either ‘high’ or ‘low’ outlet density based on the number of outlets within a 0.5-mile buffer zone [275]. Positive associations have been demonstrated between the number of outlets in a buffer zone and both consumption levels and assault rates [288, 360].

The third type of central point is the centroid of the geographic unit. This can been used as a proxy for the centre of the neighbourhood [280] or a proxy for the place of residence when the street address of those affected by alcohol-related harms is not known. Using the centroid as proxy for place of residence can be justified if, as Scribner and colleagues argue, outlet density affects alcohol-related harms at a neighbourhood-level, rather than at an individual-level [349]. If the mean neighbourhood distance to the outlet is more relevant than the individual distance from each place of residence to the outlet, the centroid of the geographic units is a more appropriate central point than individual place of residence.

Two studies in New Zealand have used centroids of meshblocks[31] to calculate the distance to the nearest alcohol outlets [280, 281]. Both studies used a population-weighted centroid, that is, the population centre (rather than the geometric or geographic centre) of the meshblock. Pearce and colleagues regarded this centroid as the centre of the neighbourhood [280]. The sizes of the two buffer zones were chosen to represent an easy walking distance (800 m) and an easy driving distance (3,000 m) respectively. The authors note that using a population-weighted centroid is necessary when analysing rural areas in New Zealand, where large geographic areas contain relatively small, scattered populations. Thus, in a densely populated metropolitan area such as Perth, the difference between population-weighted and geographic centroids might be less important.

A further issue to be considered is the size of the buffer zone used for an analysis. In some criminology studies, the size of the buffer zone is based on the distance from the centroid at which the count (e.g. of households) reaches a predetermined threshold [377]. In contrast, outlet density research tends to use buffer zones at pre-set distances from the central point [275, 283]. The appropriate size of a buffer zone is related to the nature of the central point and the type of outcome to be counted. For example, if the researcher is counting the number of assaults that occur around a nightclub, the size of the buffers would be relatively small, as assaults tend to occur close to the place of drinking [220, 288]. Conversely, alcohol-related road crashes may occur at greater distances from outlets and so if this is the outcome under examination, then larger buffer zones would be more appropriate. Distance relationships will differ with other alcohol-related harms such as domestic violence (IPV), child maltreatment and suicide. Potentially, these distance relationships vary between on- and off-premise outlets.

When using place of residence as the centroid, knowledge of routine activities may guide the choice of buffer size. For example, studies have used buffers which approximate walking distance [280, 378] and five-minute driving distance [280]. These measures may also be city-specific, for example, approximating the size of a city block [220]. In many cases, the choice of buffer size has been on an ad hoc basis, sometimes policy-driven (for example, to make evaluations of legislative policies [220], and sometimes based on the researchers’ expertise [378].

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[31] A meshblock is a small geographic unit used in New Zealand censuses representing approximately 100 people.

When constructing buffer zones, two methods can be used to calculate distance: straight-line distance (‘as the crow flies’ or Euclidean distance), and the road network distance [378]. The straight-line distance method has been using in studies when the place of residence is the central point [80, 275, 276, 280, 283] and when a college campus is the central point [208]. The disadvantage of this method of calculating distance is that it ignores barriers to travel (such as bodies of water) and the road network (such as rail tracks and highways) [378].

Road network distance (or street distance) can be calculated by GIS software such as ArcGIS [379]. Several alcohol availability studies have calculated network distance from place of residence to alcohol outlets. Those outlets which fell within a pre-defined road network distance from the point of origin were counted in that zone [281, 318, 360].

Only one alcohol availability study has compared the two methods of measuring the size of buffer zones. Pasch and colleagues calculated both straight-line and road network distance around home and school, to alcohol outlets, and analysed the data for each measure in turn [329]. No significant associations were found with alcohol use or drunkenness in the last 30 days among adolescents, using either measure of proximity. The p-values for the two methods were slightly different but it was impossible, from the analysis presented, to draw conclusions on the merits of the one method over the other.

The road network distance could be an appropriate method of measuring distance if: i) there is an accurately geocoded place of residence; ii) major topographical features such as bodies of water may affect access to outlets, making straight line distances misleading; and iii) the assumption is made that people travel purely by road to access alcohol. This is a reasonable assumption if people drive themselves to purchase alcohol, but less so for those who walk or use public transport (which follows strictly defined road or rail routes). Further, the road network may not connect to ‘nearby’ outlets [280]. In these cases, using straight-line distance is more appropriate.

A number of availability studies have created several buffer zones around each central point (whether outlet, place of residence, geometric or population centroid) [327, 361]. Analyses of multiple buffer zones around each central point can be used to track how associations increase or decrease over distance, depending on the alcohol-related harm or outlet type. With harms such as assault, ‘decay’ is expected as the distance from an on-premise outlet increases, that is, the outlet will have declining influence on assault further from the outlet, leading to weaker associations between harm and outlet counts as distance from the central point increases[378, 380].

In summary, when using buffer zones in alcohol availability research, several decisions need to be made: the shape of the buffer zone (concentric is preferred); what will represent the central point around which the buffer zone is constructed; the size of the buffer zone; how to calculate the size of the buffer zone, and the number of buffer zones to be used. The characteristics of the study area, and the type of alcohol-related harm or harms and alcohol outlets included in the analysis all need to be taken into account when deciding on the nature of the buffer zones.

3.9.3 The choice between random effects and fixed effects models when using panel data

In epidemiological research, panel data have many advantages over cross-sectional data. Panel data have two components, namely a time variable (such as the year) and a panel (or cross-sectional) variable (such as a school or geographic area). Making use of both components increases the statistical power of the analysis because the number of units of analysis is the product of the number of time periods and the number of panel units. Panel data also allow changes over time to be modelled. Using cross-sectional data at a single point in time can result in inaccurate or even reversed associations.

The structure of panel data (consisting of both a temporal and a panel component) can lead to violation of the assumption in regression analysis that observations are independent of each other. Because data are clustered in time and space, data within each cluster may be more similar than data in other clusters. If the violation of independence is ignored, the estimated standard errors may be too high or too low, and there is an increased risk of Type I or Type II errors [264, 381].

Regression analysis for panel data with random effects explicitly allows for clustering of data, allowing the average response to vary among clusters or panels [381]. The underlying structure in the data is accounted for by including a term that varies randomly among clusters in the regression model. This is known as the ‘random effect’. The random effect follows a probability distribution. In the case of negative binomial regression, the random effect follows a beta distribution, while the outcome variable follows a negative binomial distribution [381, 382]. Random effects models are also known as multi-level, mixed, hierarchical and cross-sectional time series models. As implied by the latter name, these models can be used to analyse data containing repeated measures over time (longitudinal data). Random effects models can be used with other types of clustered data as well, for example, observations of schoolchildren from several schools—the school would be the cluster.

Other types of models which may used for panel data are fixed effects (time-fixed or cross-sectional unit-fixed) and mixed effects (which include both random and fixed effects). Fixed effects models are used extensively in econometrics. They are regarded as consistent, although random effects models yield more efficient (but less consistent) estimators of the parameters (the standard errors will be smaller) [383].

Econometricians recommend the Hausman test to choose between fixed and random effects models. This tests the assumption that *“there is no residual correlation between individual-level predictors and neighbourhood-level random effects”* (p. 544 [383]). If the test statistic is not significant (that is, the null hypothesis of no residual correlation cannot be rejected), the more efficient random effects model is preferred over the fixed effects model.

However, it has been argued that a random effects model is appropriate if the researcher is interested in the influence of contextual variables (group variables), while a fixed effects model is appropriate if the researcher is interested purely in variables that change at an individual-level. The Hausman test is not necessarily helpful if the context of the data is an important factor in deciding between random effects and fixed effects models [384].

The choice between random and fixed effects models is compounded by the widely differing definitions of random and fixed effects, which vary both between and within the disciplines of econometrics and biostatistics. Many biostatisticians and epidemiologists have tended to favour random effects models [381, 383, 385], while econometricians prefer to use fixed effects models [386].

3.9.4 The implications of the spatial nature of alcohol-related harm and alcohol availability data

According to Tobler”s first law of geography *“Everything is related to everything else, but near things are more related than distant things”* [387]. Traditional regression models allow for changes over time, and clustering by spatial (or geographical) unit. However, traditional regression models assume that the associations between the dependent and independent variables are consistent across the total study region (homogeneity) and do not allow for associations which vary across space (heterogeneity) [388]. Furthermore, traditional statistical methods do not account for the potential of one geographic unit to influence nearby geographic units (spatial dependence). Various spatial models have been developed to allow for either spatial heterogeneity or dependence.

Spatial heterogeneity

There are several types of models which allow for spatial heterogeneity in associations between dependent and independent variables. These include spatially adaptive filtering, multi-level modelling, and an extension to random coefficient models. A recent type of regression (which is available in ArcGIS, SpaceStat and free software such as GeoDa) is Geographically Weighted Regression (GWR) [388]. GWR is a local form of linear regression used to model relationships that vary spatially (i.e. spatial heterogeneity) [389]. *"GWR constructs a separate equation for every feature in the dataset incorporating the dependent and explanatory variables of features falling within the bandwidth of each target feature"* [389]. Thus, if the target feature was the geographic centroid of the postcode, all dependent and independent variables that are located within a defined distance from the postcode centroid would be included in the regression equation, and a regression equation would be constructed for each postcode.

The issue of spatial heterogeneity has not occupied alcohol outlet density researchers, possibly because research in the area in the last 15 to 20 years has largely focused on smaller geographic regions within cities or counties. It is likely that larger regions (such as states or countries) would be less spatially homogeneous. In some studies using larger geographic areas, heterogeneity has effectively been tested and controlled for by stratifying according to sub-region. For example, in Western Australian research including data across the state of WA, models were formed for each of five regions within the state, and the results were compared [29].

Spatial autocorrelation

As stated above, traditional regression models[32] do not take into account that a geographic unit might be more similar to the unit adjacent to it than to a unit distant from it, or that the characteristics and events in one geographic unit may affect an adjacent spatial unit. These patterns are manifested in the spatial structure of the residuals of the traditional regression model [388]. This may be explained thus: the residuals represent the difference

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[32] In this context, traditional regression models refer to non-spatial regression models, which do not account for the spatial structure of data.

between the values predicted by the regression model and the actual values of variables. As a traditional regression model is not able to model overtly for spatial dependence, the residuals of the model will reflect any unexplained spatial structure in the data. This is known as spatial dependence or autocorrelation. Positive spatial autocorrelation refers to adjacent areas being more similar to each other than would be expected, while negative spatial autocorrelation suggests that adjacent areas are less similar than would be expected [390].

Spatial autocorrelation occurs in analyses in a variety of disciplines including geography, epidemiology and econometrics. Approaches towards it vary between and within these disciplines. Geographers and geostatisticians typically regard spatial autocorrelation as indicative of a useful spatial pattern ('substance') rather than something which needs to be 'controlled for' (a 'nuisance') as it has traditionally been regarded in epidemiology [390-392]. How spatial dependence is interpreted depends on the context and perspective of the researcher [390]. Spatial autocorrelation could be interpreted as a nuisance parameter; needed to create a 'good' model; providing a fuller understanding of an underlying process; resulting from 'spillover' from an adjacent location; due to areal unit demarcation (i.e. Modifiable Areal Unit Problem); or as indicative that a model may be missing an important predictor.

If data with a spatial component is not analysed using a spatial model, this could result in a Type I or Type II error (i.e. mistakenly finding associations that do not exist, or failing to identify associations that do exist, respectively) and biased estimates of effect [264]. Non-spatial models make the assumption that individual error terms result from a population that is randomly mixed: *"…the probability of a value taken on by one of a model's error term entries does not affect the probability of a value taken on by any of the remaining error term entries (i.e., the independent observations assumed in classical statistics)*" (p. 3 [390]).

Since the mid-1990s, some alcohol outlet density researchers have argued that the residuals of non-spatial models should be tested for the presence of spatial autocorrelation [264, 393]. Other researchers, however, contended that there was no evidence that spatial autocorrelation made a meaningful difference to results and that testing and adjusting for spatial autocorrelation was unnecessary [263]. Scribner and colleagues argued that *"the problem is not one of potential bias in the coefficients but rather potential bias in the standard errors'* (p. 316 [263]).

In the last decade, most alcohol outlet density studies have included a test for spatial autocorrelation. When the test statistic has indicated significant spatial autocorrelation, spatial models have been developed. Frequently the spatial models have been similar to the non-spatial models [279]. It seems that the presence of spatial autocorrelation and its influence on relationships with alcohol-related harm depend on the size of the geographical area examined and the characteristics of the region of interest.

The presence of spatial autocorrelation can be identified using standard tests for local and global Moran's I(ndex), Geary's C(ontiguity index) and Getis (-Ord General) G. Calculating local Moran's I produces a statistic for each geographic area (e.g. each postcode) in the dataset and gives a detailed indication of clustering and hotspots. Global Moran's I represents the mean of all the local Moran's I statistics for the whole region studied and therefore is a measure of overall spatial autocorrelation (assuming homogeneity across the region). The alcohol outlet density literature has tended to use the global Moran's I [14, 29] for identifying spatial autocorrelation.

Moran's I is usually calculated using the residuals of the non-spatial model[33] and the chosen spatial weights matrix (see 4.7.1 for a discussion of spatial weights matrices). The range of the statistic is –1 to 1, with zero indicating a random spatial pattern. A negative statistic indicates that data are more spatially dispersed than expected (negative spatial autocorrelation) and a positive statistic indicates that data are more similar to data in the adjacent geographical area than expected (positive spatial autocorrelation).

Depending on the nature of the spatial dependence, different types of spatial models are used. A spatial error model is appropriate when there is structure in the residuals of the model (indicated by a significant test statistic using the Lagrange Multiplier (LM) test for spatial error). The spatial influence is modelled in the error term of the regression equation [394].

A model with a spatial lag term is used when the variables of the models have a spatial structure (indicated by a significant test statistic using the LM test for spatial lag). Spatial lag models take into account the effects of the dependent or independent variables on adjacent or nearby areas [395]. Spatial lag models are also known as spatial autoregressive models when the dependent (outcome) variable is affected by magnitude of the dependent variable in neighbouring areas [394].

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[33] Moran's I can be calculated using an independent variable/s or the residuals of the non-spatial model.

Two further types of spatial models are the spatial Durbin model and the general spatial model. The spatial Durbin model includes a term to represent the average neighbour values of the independent variables in the regression model [394]. The general spatial model incorporates both a spatial lag term and a spatial error term, but is rarely used in practice because of difficulties in defining the spatial weights matrices needed to construct this model [394]. It is not currently possible to develop spatial Durbin models or general spatial models with panel data in commonly used statistical programs.

3.10 Summary

This chapter undertook a review of the literature relating to alcohol in the ED and alcohol availability. Both international and Australian literature confirmed the role of alcohol in injuries presenting to EDs. The review explored the difficulties of defining ‘injury’. The benefits and limitations of various methods of identifying alcohol-involvement in EDs were explored, and a review of surrogate measures of alcohol-related harms was undertaken which highlighted that nights and weekends were the time periods in which alcohol was frequently involved in injury. These findings were used to inform the methods used in Phase one of the project.

The second part of the literature review discussed several theories that are used to explain the associations between alcohol availability and harms. The importance of physical and economic availability in contributing to consumption and alcohol-related harm was explored further. While a large body of literature has shown that alcohol outlet density is associated with a variety of alcohol-related harms (particularly violence), there is little research on alcohol sales, and its association with alcohol-related harms. As yet, differences in the associations between alcohol-related injury and on- versus off-premises outlets have not been clearly demonstrated and explained, particularly using longitudinal data.

Various methodological issues specific to the current study were explored, including the rationale for choosing buffer zones to analyse data (including choice of size, shape and central point) , and the challenges of using data with both spatial and temporal components. This literature was used specifically to inform the more technical aspects of Phases three and four, including geographical and spatial methods and choice of statistical models

4 Hypotheses, design overview and methodology

This chapter introduces the study hypotheses (4.1) and study area (4.2) and provides an overview of the methodology of the study. It outlines the four phases of the study (4.3 to 4.7). Finally the ethical considerations of the study are discussed in 4.8.

4.1 Hypotheses

The following hypotheses will be explored in this study:

(a) Night-time hours are peak times for alcohol-related injury presentations at Perth Metropolitan EDs. Injuries occurring during weekend night-time hours are a strong proxy for alcohol-related injury. (This relates to the development of a surrogate measure for alcohol-related injuries, based on time).

(b) In a given area, the level of wholesale alcohol purchases is significantly associated with the risk of alcohol-related injury requiring ED attendance. The magnitude of this relationship will vary by licence type and beverage type.

(c) For a given 'real price' of alcohol, higher levels of consumption will occur where the average distance from place of residence to alcohol outlets is less.

(d) The risk of alcohol-related injury requiring ED attendance will be greater where the average distance travelled from place of residence to obtain alcohol is less.

(e) The strength of the relationship between alcohol-related injury requiring ED attendance and outlets will vary by licence type.

(f) Alcohol outlet density and sales are independently associated with alcohol-related injuries at EDs according to the type and location of outlets, and these relationships are mediated by the distance from place of residence to outlets.

4.2 The study area and population

The study area was the Perth Metropolitan area, defined as the Perth Statistical Division (SD) of the state of Western Australia (ABS location code 505) [396]. Those postcodes specified in the ABS Postal Area Concordances for the Perth SD were included in the study [397][34]. This area is bounded by: Two Rocks to the north, Wooroloo, the Lakes and Gorrie

[34] The ABS geographical classification of the Perth area (and those of other capital cities) changed to the Perth Greater Capital City Statistical Area at the time of the 2011 census**.** Since the 2006 census

to the east, Singleton and Karnup to the south, and the Indian Ocean to the west [398]. Notably, the 2006 ABS definition excluded Mandurah but included Yanchep and Two Rocks. The metropolitan area extends approximately 50km to the north and south of the CBD, and approximately 45km to the east of the CBD [399].

As of the 2011 national census (9 August 2011), the population of the Greater Perth Area was 1,728,867, of which 858,305 (50%) were male. The median age was 36 [400]. A total of 27,105 (1.6%) people of Aboriginal and/or Torres Strait Islander origin resided in Perth. These estimates represented an increase of 29% in the total population compared to the 2001 census (which recorded a total population of 1,339,993, including 656,798 (49%) males and 19,001(1.4%) people of Aboriginal and/or Torres Strait Islander origin) [401].

4.3 Design overview

The study was conducted in four phases: i) Phase one focused on the identification and analysis of individual-level injury ED data; ii) Phase two undertook a panel survey of the general population on alcohol purchasing habits; iii) Phase three involved the identification, collation and analysis of volumes of alcohol sales, numbers of outlets, trading hours and socio-economic and demographic data for analysis at postcode- and suburb-level and iv) Phase four focused on the formulation of statistical models to explain the relationships between injury, location, socio-economic status, demographic characteristics and alcohol availability.

4.4 Phase One

Phase one involved the collection and processing of ED data, the validation of a surrogate measure of alcohol-related injury and preparation of the dataset using the chosen surrogate.

This phase undertook a retrospective analysis using individual-level data on alcohol-related injuries obtained from ED records for the Perth Metropolitan Area from 2002 to 2010. ED records (which included postcode and suburb of residence for each presentation) were requested from the Data Linkage Unit (DLU) which is located at the Department of Health of WA.

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fell halfway through the study period, the definitions used to define the geography of Perth Metropolitan during that census will be used.

4.4.1 Data Sources

Unique hospital identification numbers are not allocated in Western Australia. As a result, data linkage techniques are required to connect health data about individuals and families using different health services, in a way that does not impinge on individuals' privacy [402]. The Western Australian Data Linkage System (WADLS) was established in 1995, although data linkage has been used in health research in WA since the 1970s [402]. The Data Linkage branch records longitudinal data on the use of health services and vital events for the entire Western Australian population [403]. Validation studies in the 1990s demonstrated reasonably high to high levels of data accuracy (78% to 99%) across the Hospital Morbidity and Midwives' Data Systems [403].

The WADLS currently contains in excess of seven million records. The Department of Health maintains the following core datasets: the Hospital Morbidity Data Collection, the Mental Health Information System, the Western Australian Cancer Registry, the Midwives' Notification System, and the Emergency Department Data Collection. Records of registrations of births, marriages and deaths, and electoral records datasets are also maintained [402].

The Emergency Department Data Collection began in 2002 and contains records of all of Western Australia's public hospitals and those private hospitals under contract with the state government. It consists of four recording systems, one of which is the Emergency Department Information Solution or System (EDIS), a proprietary software solution by iSoft (now CSC)[404]. In metropolitan WA, all public hospital EDs record patient information via the EDIS database [402].

EDIS routinely collects patient information: the principal diagnosis (ICD-10), presenting problem, triage category, age, sex, Indigenous status[35], country of birth, marital status, date and time of day of presentation, as well as residential data including postcode, SEIFA and ARIA [405]. Although the system allows for recording of external cause codes or E-codes (such as injury by interpersonal violence, fall or motor vehicle), this field is rarely completed because of limited time, perceived lack of importance of these codes by clinicians, high staff turnover due to short rotations through the ED and financial costs of altering the system to encourage use of E-codes [109].

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[35] Indigenous status includes if cases are of an Aboriginal or Torres Strait Islander origin or of both Aboriginal and Torres Strait Islander origin or not.

4.4.2 Sample Identification

For the purposes of this study, ED data was requested for the Perth Metropolitan Area for the years 2002 to 2010. The study population included**:** *"all people aged 15 and older and residing in the Perth metropolitan area who were admitted to metropolitan EDs between Jan 2002 and Dec 2010."* A complete list of Perth Metropolitan Area postcodes was provided to the Data Linkage Branch (DLB) as part of the application. This list comprised those postcodes in the ABS Perth Statistical District (505), excluding post box postcodes [397]. Only cases residing in these postcodes were provided by the DLB. All cases were de-identified to maintain privacy. No variables which could potentially lead to identification of individual cases were allowed. For example, the date of birth data included only the month and year of birth, and suburbs and postcodes, but not street addresses, of cases were provided. Certain variables, including Human Intent of Injury and External Cause, could not be used as data for these fields were missing in 99% of ED presentations. In addition, actual establishments (that is, the hospitals of presentation) were not identifiable from the records, so other sources were used to establish which hospitals used the EDIS and when they came online. Sources of this information included Department of Health reports [406] and personal communication with experts [407].

The Perth Metropolitan area contains nine public hospitals with EDs: Royal Perth Hospital; Sir Charles Gairdner Hospital; Fremantle Hospital; King Edward Memorial Hospital for Women; Princess Margaret Hospital for Children; Armadale Hospital; Rockingham Hospital; Swan Hospital and Joondalup Health Campus[36]. EDIS was first implemented at Fremantle Hospital in February 1999, and at all other public hospitals (except the Joondalup Health Campus (JHC) and the King Edward Memorial Hospital (KEMH)) between February 2002 and 2003 [406]. JHC began using EDIS in late July 2004 [406] and KEMH in 2005 [407].

A report on Perth Metropolitan ED usage indicated that in the financial year 2003/4, 41,061 cases presented at the JHC ED[37] [406]. This represented 13.2% of all recorded ED presentations (excluding KEMH[38]). JHC ED presentations represented a similar proportion of presentations in 2004/05. Given these similar proportions, metropolitan EDIS data are estimated to provide approximately 87% of all public hospital ED presentations in Perth

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[36] Joondalup Health Campus contains both public and private hospital components.
[37] This was prior to EDIS being implemented at JHC
[38] KEMH was not using EDIS in 2003/4

prior to the middle of 2004. For this study, various options were considered to correct for the absence of JHC from EDIS for 2002/03 and 2003/04 including:

(a) Creating models which excluded all ED presentations in the financial years 2002/03 and 2003/04, and comparing these to the models for the full time period from 2002/03 to 2009/10;

(b) Obtaining ED presentations for these years directly from JHC (requiring direct application and ethical clearance from the hospital) and adding these to the database obtained from the DLB; and

(c) Obtaining hospital admissions data for the JHC from the Department of Health, and estimating the ED presentations from this data.

Using either of the latter two options would have involved making many assumptions about the proportions of ages, gender and time of injury of ED presentations. The results would be of questionable accuracy. Option (a) was therefore the preferred approach. The models formulated in Phase four were constructed for both the full study period (2002/03 to 2009/10) and for the time period after which JHC joined EDIS (2004/05 to 2009/10). This facilitated assessment of the impact of the lack of JHC ED data for the years 2002/03 and 2003/04. The differences between the two models are demonstrated and discussed in 7.2.9.

KEMH is primarily a specialist hospital (for gynaecological, maternity and neonatal care) and records a small proportion of total ED cases in Perth Metropolitan Area (for instance in October 2005, only 2.88% of all ED presentations in the public hospitals in Perth were at KEMH [406]). Given the nature of the speciality, it is probable that a very high proportion of ED presentations involved pregnancy and gynaecological issues, and that a lower proportion of alcohol-related injuries presented at KEMH than at general hospitals.

Perth has one entirely private hospital with an ED: St John of God Murdoch Hospital. This ED does not use EDIS [408]. It has been estimated that this would lead to a shortfall of 5.4% in total metropolitan ED attendances recorded [409].

4.4.3 Surrogate measures of alcohol-related injury

As neither blood alcohol concentration or self-reported alcohol consumption are recorded, it is not currently possible to directly identify all alcohol-related cases treated in Perth EDs (for example alcohol-attributable falls, road crashes) except where the condition is, by definition, attributable to alcohol (e.g. alcohol poisoning) [164]. Therefore, a surrogate measure was used to identify likely alcohol-related injury cases in this study.

The suitability of the surrogate approach for WA ED data was verified using an approach established by Evans et al. for identifying alcohol-related injury presentations to South Australian EDs [164]. This involved examining the temporal distribution of all ED cases in WA known to be directly attributable to alcohol and identifiable from ICD-10 primary diagnostic codes, such alcohol poisoning (T51.0), alcohol intoxication (F10.0) and alcohol-induced acute pancreatitis (K85.2) [106]. The peak times of presentation were then identified.

In order to carry out the validation process, the datasets provided by the DLB were prepared for analysis in Stata 12 [410]. Only cases over the age of 15 years, where 'type of presentation' was classified as 'emergency', were retained; admissions resulting from transfers from other hospitals, planned admissions and planned reviews were removed from the dataset. Cases with missing or unknown variables in the following fields were excluded: age, gender, presentation time and ICD-10 (diagnostic) code. This followed the exclusion criteria used by Evans et al. [164] with the South Australia ED data.

Individual time variables were disaggregated using the presentation time variable. 'Weekend' was defined by Young et al. as presentations occurring at any time on Friday, Saturday and Sunday [371]. A further variable was created for weekend (weekend_mod) with a different definition: (Friday 18:00 to Monday 06:59) – this was considered to be a more accurate time period to measure injuries involving alcohol at the hypothesised higher risk period of the weekend. It excluded early Friday morning but included early Monday morning, the time period at which injuries relating to Sunday evening drinking might present to EDs.

The primary dataset was used to create two secondary datasets: injury cases and wholly alcohol-attributable cases. The criteria used to establish these datasets are discussed below. For the validation process, data from 1 July 2002 to 30 June 2010 was used, because sales data was only available for this time period, and is provided in financial years.

The definition of injury used in this study is similar to the definition used by Bradley and Harrison [411] and Evans et al. [164]. Bradley and Harrison define the cases included as 'community injuries': that is, those occurring at home, in the workplace, educational institution and outside environment [411]. Thus, injuries resulting from medical or surgical treatment were excluded from the definition of injury. All EDIS cases with a primary diagnosis of an injury were included in the injury dataset: those allocated ICD-10 codes between S00.0 and T98.3 (Chapter XIX: "Injury, poisoning and certain other consequences of external cases”, ICD-10-AM) and selected codes from V01 to Y98 (Chapter XX: “External causes of morbidity and mortality”). Following the method described by Evans and colleagues [164], the following cases were excluded: cases classified as involving “complications of surgical and medical care, not elsewhere classified” (T80-88); “sequelae of injuries, of poisoning and of other consequences of external causes” (T90-T98); “complications of medical and surgical care” (Y40-Y84); “adverse effects not elsewhere classified” (T78); “other specified complications of trauma” (T89), and “sequelae of external causes of morbidity and mortality” (Y85-Y89).

Wholly alcohol-attributable cases were identified using the following ICD-10 codes: “mental and behavioural disorders due to use of alcohol” (F10); “alcohol-induced acute pancreatitis” (K85.2); “finding alcohol in blood” (R78.0); “toxic effect of alcohol” (T51); “accidental poisoning by and exposure to alcohol” (X45); “intentional self-poisoning by and exposure to alcohol” (X65); “poisoning by and exposure to alcohol, undetermined intent” (Y15); “evidence of alcohol involvement determined by blood alcohol level” (Y90); “evidence of alcohol involvement determined by level of intoxication” (Y91); “blood-alcohol and blood-drug test” (Z04.0); and “alcohol use” (Z72.1). A similar set of conditions was used by Evans et al. [164].

Validation procedure:

Potential surrogate measures were validated with data from Perth EDs for each of the years from 1 July 2002 to 30 June 2010 using the methods described by Evans and colleagues [164]:

(a) The proportions of all cases matching the potential surrogate measures used by Young [168] were compared for South Australia (SA) 2009/10 data, the Perth data, and data used by Young and colleagues.

(b) The temporal distribution of wholly alcohol-attributable cases was compared to the temporal distribution of all injury cases.

(c) The temporal distribution of younger (15 to 44 year old), male, weekend wholly alcohol-attributable cases was compared to that of all wholly alcohol-attributable cases.

(d) The proportion of injury cases presenting at Perth EDs during time periods which were highly likely to be non-alcohol-related were compared to proportions of injury cases during time periods which were likely to be alcohol-related.

(e) The proportion of weekend only wholly alcohol-attributable cases was compared to all wholly alcohol-attributable cases.

One of the surrogate measures originally explored by Young [371] was marital status but it was not pursued in this study as in a high proportion of the Perth EDIS records (approximately 25%), did not provide data on marital status.

Following verification, alcohol-related ED injury cases were identified using the two validated, preferred surrogate measures (Night2 injury - injuries occurring between midnight and 04:59am, and modified Weekend Night2 injury- injuries occurring between Friday night and Monday morning between midnight and 04:59am). Data was cleaned and plausibility checks were undertaken. Each surrogate measure was collapsed into two geographical areas, postcode and suburb, creating two injury datasets for each surrogate measure. The database was checked to ensure that all postcodes included in the dataset were confined to the Perth Statistical District (SD) [412]. Identifying the suburb of residence was more difficult than identifying the postcode as several hundred entries recorded the road of residence, rather than the suburb of residence. Each of these was cross-checked with postcode of residence to identify the correct suburb. In less than 1% of cases, the suburb and postcode did not match (for example “Geraldton 6101”). These records were removed from the dataset.

Statistical Analysis

Descriptive statistics of the ED dataset, as well as the two subsets of all injuries and wholly alcohol-involved cases, were carried out. Validation of surrogate measures of alcohol-related injury followed the method described above, using all injury and acute wholly alcohol-involved datasets. In addition Pearson’s correlation tests of the three datasets (total ED, all injury and wholly alcohol-attributable presentations) and time period variables were undertaken.

A negative binomial model was run with counts of injury as the outcome, allowing for clustering by postcode. The model included age category, gender, weekday or weekend, day or night and year of presentation as predictors of presentation at an ED with an injury. Descriptive statistics of the preferred surrogate measures were calculated for the period from mid-2002 to mid-2010 and the results presented in Chapter four.

4.5 Phase two: online survey

The survey was undertaken to establish how far consumers were prepared to travel to purchase alcohol under various conditions.

4.5.1 Study Design

An on-line cross-sectional general population survey was used to inform Phases three and four.

4.5.2 Overview of Questionnaire

ED staff do not collect data on the place of drinking or place of alcohol purchase by injured patients. It is, therefore, impossible to directly confirm whether people tend to purchase alcohol within the postcode where they reside or whether they usually travel into neighbouring postcodes or even further afield to obtain alcohol. The online panel survey attempted to determine typical distances travelled to obtain alcohol from off-premise (bottle shops and supermarket liquor stores) and on-premise (restaurants, cafes, taverns, hotels and nightclubs) outlets. This information was used to determine the size of buffer zones required for geographical analysis in Phase three. The survey began by asking a series of demographic questions and also asked questions on the effect of different price discounts on distance travelled to access alcohol, by alcoholic beverage type and licence type.

Pilot Testing

Pilot testing of the questionnaire was undertaken to test the reliability and validity of the questionnaire as well as the appropriateness of the questions to the target group. The aim of the pilot study was to determine: whether survey instructions and items were easy to comprehend and unambiguous; if the survey items flowed in a logical manner; whether certain items were regularly unanswered; and if travel distances and times, and specific discounts on alcohol were appropriate and sufficient to demonstrate actual purchasing behaviours.

Pilot participants were recruited in October and November 2011 using convenience sampling. Participants were recruited using the following methods:

(a) Twenty colour A4 posters placed at shopping centres, libraries and recreation centres in Perth

(b) A press release in a community newspaper

(c) A recurring community notice on Curtin FM radio station (a community station aimed at listeners over 45 years old) [413]

(d) A5 flyers handed to personal contacts in the community

(e) An advertisement was posted in the "Latest News" section of OASIS, Curtin University's portal for university-related electronic services

(f) Family members and friends of participants (snowballing)

When potential participants emailed or phoned, they were given basic information about the survey and placed on a list. Within two weeks, each person was contacted to arrange a suitable group date and time, and asked to recruit further interested people as participants.

With the permission of the Health Sciences Graduate Studies Officer, questionnaires were completed at the Curtin Health Sciences Graduate Research Hub at Technology Park, Bentley. Participants were provided with refreshments. Each participant was given a $30 Coles group voucher as a token of appreciation for the time taken to travel to the venue and complete the survey.

Pilot study participants were required to give written consent to take part in the survey and the group discussion about the questionnaire. Before the questionnaire was given to participants, they were given a written explanation of the procedure to be followed, the meaning of informed consent and anonymity, the voluntary nature of participation and assurance that confidentiality would be maintained. The participants were given a brief verbal explanation of the above issues and any questions were answered. Participants then signed and dated the consent forms, separately for the questionnaire and the group discussion. Following this, the participants completed the questionnaires and then participated in the group discussion.

Nine to eleven days later, a retest of the identical questionnaire, which aimed to test the reliability of the questionnaire [414], was performed with the same participants. In order to link the anonymous test and retest versions of the questionnaire, each participant was allocated a number which was written on both questionnaires. This number was known only to the PhD student and the participant.

A password protected document was created which contained the link between unique identifiers, names, telephone numbers and email addresses of participants. This enabled follow-up by phone or email (by the student only) to validate distance travelled when each participant next purchased alcohol. Participants were contacted to validate the distance travelled when they next purchased alcohol. The initial follow-up call or email took place 10 days after completion of the questionnaire. (The method of follow-up depended on the preference and availability of each participant.) Participants were followed up again if they had not purchased alcohol during the initial time period.

After the pilot study was completed, adjustments were made to the questionnaire. These are discussed in detail in Chapter five.

Online survey

An experienced web panel provider, Pureprofile, was contracted to host and disseminate the survey to their web panel members. Pureprofile is an international panel provision and customer database management provider with 344,874 Australian accountholders across a range of ages, genders, education levels and locations [415].

Using a panel organiser enabled the detailed selection of a geographically dispersed panel with a range of socio-economic and demographic characteristics, thus circumventing a potentially limiting factor for online and email surveys. Australian phone and paper-based alcohol surveys typically yield very low response rates (< 50%) and are expensive to conduct [416]. Contact rates of telephone surveys are decreasing, with mobile telephones replacing landlines, and more sophisticated call screening technologies [417].Web panels are increasingly being used in social research due to their reach, cost-effectiveness, and speed [418-420]. Comparison studies suggest that web-based surveys produce comparable results to those generated in laboratory studies [421].

Pureprofile was used to identify and recruit a nationally[39] representative sample of major metropolitan areas [422]. Perth and other capital city metropolitan areas with similar demographic profiles to WA were selected (Sydney, Melbourne, Brisbane, Adelaide, Canberra and Hobart). Other capital cities were included as the Pureprofile database was not large enough to produce a representative sample of Perth alone. Darwin, the capital city of the Northern Territory, was excluded due to its atypically high rates of risky and high risk drinking, and demographically distinct population (higher proportions of remote, young, and Indigenous people) [416].

Using a standard error of 2.5% and allowing for separate analysis by gender, a sample size of 800 was calculated (see Appendix 10.6). Pureprofile set up the survey sample so that there was a spread of age categories and approximately equal numbers of male and female respondents. In order to allow for analysis by SEIFA[40] categories, each Australian

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[39] It was anticipated that the survey needed to be nationally based in order to generate a sample of sufficient size

[40] SEIFA or the Socio-economic Indexes for Areas consist of indexes of relative advantage, disadvantage, economic resources, and education and occupation. Groups of variable relate to

capital city residential postcode was categorised by its SEIFA quartile [423]. Pureprofile was given a list of the postcodes of all capital cities (excluding Darwin). Each postcode was allocated a SEIFA category between one and four. Quotas were set so that each SEIFA quartile constituted approximately 25% of the sample. The sampling quotas set by Pureprofile are shown in the Appendix (10.7). The survey was run in late May 2012.

4.5.3 Statistical Analysis

The frequencies of demographic characteristics of participants, quantity and frequency of drinking, distances participants were prepared to travel, location of alcohol purchase, type of beverage preferred, and the effect of price discounting were analysed. The findings about the distance participants were prepared to travel at each outlet type were stratified by age, sex and SEIFA quartiles, and the categories were compared using chi square tests. On the basis of this initial analysis, the size of buffer zones required in Phase three was chosen. Analyses were performed in Microsoft Excel [424] and Stata 12 [410].

4.6 Phase Three

The third phase of the project involved the collection and collation of the different datasets required for the development of final models. Three main subsets of data were prepared: i) ED injuries (using the two surrogate measures of alcohol-related injury: Night2 and Weekend Night2)[41]); ii) alcohol data (by buffer zone); and iii) Australian Bureau of Statistics (ABS) socio-demographic data. Each of these was prepared at both postcode- and suburb-level. These three subsets were merged in Stata, ready for the final analysis stage, Phase four. Thus two complete final datasets were created: one at postcode-level and one at suburb-level.

4.6.1 Study Design

Phase three consisted of a retrospective population-based study of ED, alcohol availability and general population data from mid-2002 to mid-2010.

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education, income, employment, occupation, housing and other measures of advantage and disadvantage.

[41] The modified weekend definition was used to create this dataset, that is, Friday night to Monday morning.

4.6.2 Data Sources and Methods

This phase involved the collation of data from various sources: i) alcohol outlets, trading hours and sales of these outlets, obtained from the WA Drug and Alcohol Office; ii) ED alcohol-related injuries (using the surrogate measure validated in Phase one); and iii) population data obtained from the ABS web-site [425] and the Rates Calculator program developed by the Department of Health of WA [426].

Choice of buffer zones

To assess how distance from place of residence of alcohol-related injury cases to alcohol outlets mediated the relationship between alcohol availability and alcohol-related injury, it was necessary to establish a geographic link between the two sets of data. To protect the identity of ED cases, only suburb and postcode (not street address of residence or location of injury) were provided by the DLB. In this study, the geographic centroid of the postcode of residence was chosen as a proxy for place of residence (as discussed in 3.9.3). Because all the data came from one metropolitan area, the geographic centroid was preferred to the population-weighted centroid (see 3.9.3). Data was also analysed at suburb-level.

This study included injuries cases presenting at EDs within the time period of the preferred surrogate of alcohol-related injury. Therefore, those with less severe injuries, who may have seen their GPs or not sought medical attention, are not included in this database.

Cases of alcohol-related injury presenting at EDs may result from a range of external causes such as assault, road crashes and suicide. Injuries from different causes may have distinct geographical relationships with alcohol availability. For example, assaults may tend to occur closer to outlets and residences, and road crashes may occur further from alcohol outlets. Because of the range of causes (and the lack of external causes data in the EDIS), the sizes of buffer zones used in previous studies (3.9.3) were not directly applicable to this analysis. As discussed above, the radii of the buffer zones were established using the online survey: the distances that Australians living in metropolitan areas were prepared to travel to obtain alcohol.

Participants in the focus groups conducted during the pilot phase of the survey suggested that it would be relevant to include distances of less than 5km from place of residence to alcohol outlets. The radius of each buffer zone effectively functioned as a proxy for straight line distance from place of residence to outlet. Based on this, five buffer zones were chosen (using the straight line distance measured from the geographic centroid of the postcode or suburb): i) outlets within 1km; ii) outlets within 2km; iii) outlets within 5km; iv) outlets within 10km; and v) outlets within 20km of the postcode or suburb centroids. Outlets were then allocated to the relevant categories (see Figure 4.1). Buffer zones were not mutually exclusive: some outlets could be included in multiple buffer zones (within the same postcode or suburb, or in more than one postcode or suburb) and others were in no buffer zones (for example if the outlet was located in postcode with a large geographic area, a long distance from the centroid of that postcode and the adjacent postcodes.)

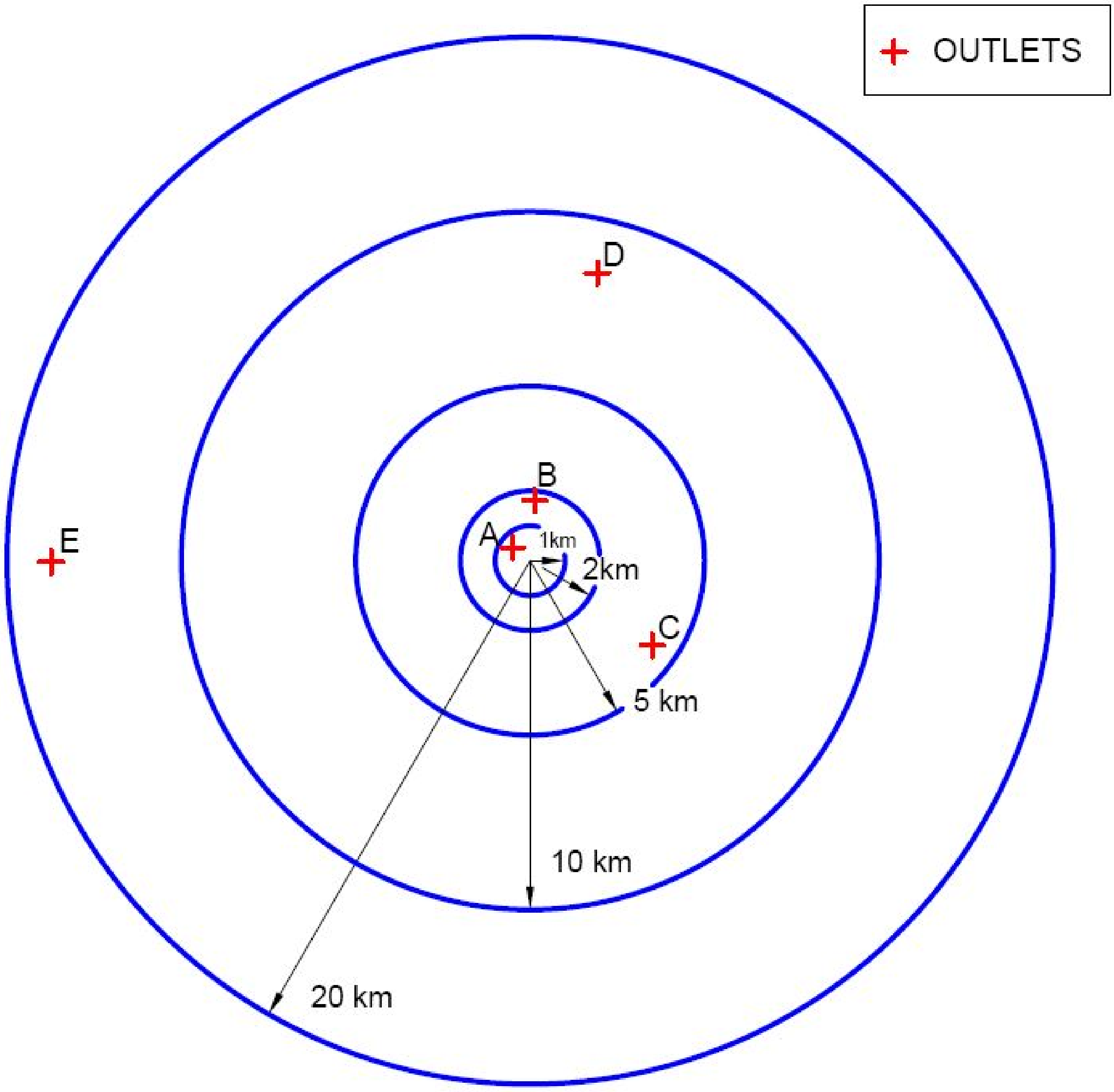

Figure 4.1: Schematic diagram representing demonstrating the five potential buffer zones around the postcode centroid

Geographic information systems with mapping of alcohol outlets

Eight separate geographical information systems were created, one for each financial year including the alcohol outlets with active licences in that year. These were used to calculate the straight line distance from the geographic centroid of the residential postcode (a proxy for place of residence of injured persons) to alcohol outlets. This facilitated the categorisation of outlets into buffer zones to assess the proximity of injured cases to alcohol outlets ('distance to outlet').

The baseline maps used the shapefile *"Postal Areas (POA) 2006 Digital Boundaries in ESRI Shapefile Format"* [427]. Geographical locations of each licensed outlet in Perth have been previously geocoded by the Alcohol Policy Group at the National Drug Research

Institute[42]. The file of geocoded outlets for each financial year was updated by a geographer at NDRI: premise names, licence number and physical locations were cross-checked across the eight years of data.

To check the results, two different approaches were used to calculate the distances between centroids and outlets [428]. The results were similar, and the method deemed most accurate [428] was used and is outlined below. The ABS postal areas shapefile was first projected appropriately for Perth. Projected co-ordinate systems are designed for a flat surface such as a computer screen or paper (as opposed to a geographic co-ordinate system which assumes the spherical nature of the earth) [429]. Cartesian co-ordinates are two dimensional, describing location in terms of x and y co-ordinates. Different map projections correct for the shape of the earth at different longitudes and latitudes, variously preserving area, shape, distance and/or direction, and so it was important to choose the correct projection to account for the shape of the earth at the location under study [429]. The Department of Spatial Sciences at Curtin University was consulted about the correct map projection for Perth and recommended using the GDA 1994 MGA Zone 50 projection, which is available in ArcGIS [430]. The data for the alcohol outlets and geographic centroids were projected using the same map projection and distances between outlets and centroids were calculated using the 'point distance' tool, directly into linear units (metres). Straight line distance was used rather than road network distance because i) precise place of residence was not known; ii) straight line distance allowed for consumers using varying methods of transport (such as walking or taking public transport) to purchase alcohol, not all of which used the shortest road network distance; and iii) injuries which did not involve the road, such as assaults and falls, might well occur some distance from the road network (3.9.3).

The distances calculated were categorised into the buffer zones, fitting outlets into one or more buffer zones. This enabled analysis of the geographical location of outlets and residences relative to the distance between them, rather than merely analysing outlets according to which postcode they were located in. Further, using buffer zones circumvented the misleading effects of administrative boundaries (modifiable areal unit problem - MAUP[43])[44].

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[42] The Alcohol Policy Group has given permission for these to be used for this project
[43] Spatial autocorrelation relates to the greater similarity (or less commonly difference) between two adjacent geographic areas compared to two geographical areas located further away from each other [264]. Modifiable areal unit problem relates to issues in analysis because of the arbitrary placement of

A similar process was followed for the suburb maps. The suburb geographic information systems used the ABS shapefile for suburbs for 2006 [427].

Extended trading hours

Data on which outlets possessed Extended Trading Permits (ETPs), which authorised extended trading hours at licensed premises, were obtained from the Drug and Alcohol Office of WA for each of the years 2006, 2008 to 2010, and January and August 2007. Data relating to ETPs from 1995 to 1997 was obtained from the National Drug Research Institute (NDRI). This data was collected as part of a previous major project at the NDRI [30]. There was no data available for the years 2002 to 2005. By cross-referencing the records from the 1990s with the electronic records for 2006 (including starting dates of licences in the latter list), a list of outlets with ETPs permitting extended trading hours was constructed for each year from 2002 to 2005[45]. Premises was classified as having either: i) an ETP allowing extended trading hours on weeknights (Monday to Thursday) and weekend nights (Friday to Sunday), ii) an ETP allowing extended trading hours over the weekend nights only, or iii) not having an ETP allowing extended trading hours.

Wholesale sales made to retail outlets

The WA Drug and Alcohol Office (DAO) provided data on all licensed alcohol outlets in operation between July 2002 and June 2010 in Perth and their corresponding annual volumes of wholesale alcohol purchases.

Alcohol sales data fields included: annual volumes of alcohol by beverage type (i.e. high and low alcohol beer[46], high and low alcohol wine[47], and spirits[48]); licence type (i.e. hotel/tavern, restaurant/cafe, nightclub, club, other on-premise outlets and liquor store), trading name, trading conditions, licence number and address, postcode and geographical co-ordinates of outlet (page 74 [375]). Sales of outlets with no address or postcode, or without a licence number, were identified, and attempts were made to trace the missing data. Where this was unsuccessful, the records were removed (for approximately nine outlets).

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administrative boundaries, *"resulting in the generation of artificial spatial patterns."* [431]. These concepts are discussed further in 3.9.4.

[44] Data from postcode 6907, which is enclosed in postcode 6009 and is part of University of Western Australia, was discarded as there were no sales or injury data for this postcode.

[45] Using licence numbers, changes of premise name were accounted for.

[46] High alcohol beer has an alcohol content of >3.5%; low alcohol beer has an alcohol content of <=3.5%.

[47] High alcohol wine has an alcohol content of >3.5%; low alcohol wine has an alcohol content of <=3.5%.

[48] Including both pre-mixed and straight spirits.

Because of the sensitive nature of the data, the DAO required that alcohol sales data be aggregated to buffer-level within postcodes and suburbs. Consequently, sales data were aggregated to buffer-level for each of the five alcohol types provided (high and low alcohol beer, high and low alcohol wine, and spirits).

Volumes of each beverage type were converted to pure alcohol using conversion factors from various sources (Appendix 10.9): high and low alcohol beer and low alcohol wine were converted using Table 1 of the Stage Two of the National Alcohol Sales Data Project Final Report 2011 (page 37 [375]). Because of changes in the alcohol content of wine, revised estimates of high wine alcohol content have been calculated, and these were used to compute pure alcohol content of high alcohol content wine (using conversion factors from [35]). The proportion of straight spirits and RTDs (ready to drink spirits) were calculated using estimates of the market share of each type per financial year by Distilled Spirits Industry Council Australia [432]. The same document was used to calculate pure alcohol content of all spirits and straight spirits. The pure alcohol content of RTDs was calculated as the difference between the pure alcohol content of all spirits and the pure alcohol content of straight spirits. This process was repeated at the suburb-level.

Demographic and socio-economic data at area level

Annual Demographic profiles were created for each postcode and suburb using Australian Bureau of Statistics (ABS) census data for 2001, 2006 and 2011. The postcodes included in the Perth Metropolitan Area were those within the Perth Statistical District (SD) [412]. The suburbs included in the analyses were those which fell within these postcodes.

The population variables used in the final phase models were chosen after consulting the NDRI publications relating to alcohol outlets and sales in Western Australian published in 2007 [29] and 2011 [22]. Variables included: estimated resident population (15 years of age and older); SEIFA categories [423, 433]; ratio of male to female population; proportion young (15 to 24 year old) males; mean age; Indigenous to non-Indigenous ratio; and unemployed to employed ratio.

Postcode population data was accessed from the ABS web-site for the three censuses, using a variety of tools available on the web-site [397, 434]. Additional data was obtained by using the Rates Calculator program [426] from the Department of Health. Stata 12 was used to interpolate variables for the non-census years of 2002 to 2005, and 2007 to 2010.

Suburb-level data for the same variables was obtained for the 2006 and 2011 censuses. Although SEIFA data at suburb-level was available for 2001, it was very difficult to access other suburb-level data for the 2001 census and there was no SLA/suburb concordance available, so this census could not be used.

Boundary changes

Over the period of eight years, it is possible that administrative boundaries would have changed. From previous studies conducted by the NDRI, it was established that certain Local Government Areas (LGAs)[49] in the Perth Metropolitan Area had changed. For example, the Wanneroo LGA had disaggregated into two LGAs, Joondalup and Wanneroo, in the early 2000s [29]. Changes in the areas of individual LGAs were documented clearly, including the month and year of the change, by the ABS [412, 427]. Over the eight years of the study, there were seven changes to LGA borders, five of which were very small (affecting less than 5% of land area).The remaining two changes related to the LGA of Vincent, which lost two parcels of land, 55.5 hectares to the Perth LGA and 34.59 hectares to the Stirling Central LGA, on 1 July 2007 [412]. The total area of the Perth Metropolitan Area was 538,600 hectares so these changes represent a very small proportion of this.

LGA boundary changes are not directly linked to changes in individual postcode boundaries, and no data on postcode boundary changes was available. As a postcode can straddle the boundary of two LGAs, it was difficult to accurately estimate changes to postcode boundaries using changes in LGA boundaries.

In addition, ‘postcodes’ represent Australian Post administrative areas. The ABS use geographic areas called ‘postal areas’ which are very similar but not necessarily identical to postcodes [425]. Since the borders of postcodes were not readily available in a usable format, the electronic maps (and so the mapping of the alcohol availability measures) and socio-demographic characteristics used in this study related to postal areas. However, records of ED injury cases provided the postcode of residence, so potentially there were slight inaccuracies because of the different definitions used. As ‘postcodes’ and ‘postal area’ are commonly used interchangeably in Australian alcohol research (e.g. [15]), slight differences between the two areas were not of concern in this study.

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[49] A local government area is an area under the control of a local government council and is a larger geographical area than postcode or suburb.

As it was not possible to ascertain exactly which postcodes were affected by LGA boundary changes, the area of changes was relatively small and these differences might not transfer from postcode to postal area, it was decided not to attempt to adjust for any changes in boundaries. For similar reasons, no adjustments were made for potential suburb boundary changes.

4.6.3 Statistical Analysis

In Phase three, the postcodes and suburbs of injury cases were identified from ED records and linked to demographic and socio-economic census data and alcohol availability data by: postcode or suburb, and financial year (1 July to 30 June). The alcohol availability data estimated the exposure of residents of the Perth Metropolitan Areas to licensed outlets and their sales, enabling calculation of the association between alcohol availability and alcohol-related injury. The use of buffers allowed the analysis of the effect of varying distances from outlets on the risk of injury (that is, the effect of proximity). The estimated resident population of the postcode aged 15 years and older, as reported by the ABS, was used as the population at risk [434]. For the final analysis, two outcome variables were analysed: Night2 ED injuries; and modified Weekend Night2 ED injuries. Each was assessed at both postcode- and suburb-level.

Variables relating to injury counts, alcohol availability and postcode characteristics were arranged in variable sets (a) to (d) to facilitate analysis:

(a) Postcode (or suburb) and financial year (that is, the panel variable and time variable)

(b) Injury count (outcome variables estimating alcohol-related injury, as indicated above)

(c) Alcohol availability (count of on- and off-premise outlets in each postcode or suburb and buffer; total of on- and off-premise wholesale sales per buffer and postcode or suburb; and trading hours grouped by licence type, buffer zone and postcode or suburb)

(d) Postcode- or suburb-level population demographic and socio-economic variables

4.7 Phase four

In the final phase of the study, statistical models were formulated using data for the Perth Metropolitan area from 1 July 2002 to 30 June 2010: surrogate measures of alcohol-related injury cases, alcohol availability variables and postcode- (or suburb-) level demographic and socio-economic data, which were collated in Phase three. Models were developed for counts of licensed outlets and their sales within postcodes and suburbs, and for each of the five buffer zones. The models for the two largest buffer zones (outlets and sales up to 10km and up to 20km from the geographic centroid) indicated that alcohol availability variables did not predict alcohol-related injury at these distances: incidence rate ratios were 1, indicating no increase in risk associated with alcohol availability. As a result, these models were not developed further, and are not reported in Chapter seven.

4.7.1 Statistical Analysis

Descriptive statistics of the alcohol availability data (outlet counts, sales and outlets with extended trading hours) were undertaken. Postcode- and suburb-level ABS demographic and socio-economic data were defined and descriptive statistics undertaken.

Negative binomial regression models with random effects were constructed to quantify the relationship between alcohol-related injuries, alcohol availability, socio-economic status and demographic factors relating to residential postcodes. Analysis was performed using Stata 12 [410].

Negative binomial regression was chosen because of the relatively small number of alcohol-related injuries compared to the ‘at risk’ population and the likely over-dispersion of the data. It is a more conservative model for count data than Poisson regression [22].

All models were developed with random effects, which explicitly allowed for clustering of data (by postcode and financial year) to account for the underlying structure in the data. When the final models were developed (one for the total postcode or suburb, and one for each buffer zone), each model was run using random effects and then using fixed effects. Hausman tests were conducted to assist in deciding whether random effects or fixed effects should be used to account for the violation of independence among data within the same geographic area (postcode or suburb) and time period (financial year).

Controlling for potential confounders

The patterns of travel vary across Perth because of differences in road network design, levels of traffic congestion, location of commercial and retail premises, and population density across the city. These patterns potentially confound or mediate the relationship between alcohol availability and injury. It was hypothesised that the magnitude of the association between alcohol availability variables and injuries in postcodes and suburbs closer to the CBD would differ from those in outer Perth postcodes and suburbs.

Therefore, analysing data from all postcodes and suburbs in the Perth Metropolitan Area together would mask differences across the city.

A publication by the ARRB Group (formerly the Australian Road Research Board) provided a framework which was used to define the areas in Perth [435]. The publication, which aimed to develop speed-flow curves for Perth, divided the Perth Metropolitan Area into four area categories based on the distance between a pair of signals (controlled intersection) or road link as follows:

(a) CBD: the road link was about 300m (or less)

(b) Inner suburbs: road links between 300m and 1,000m. Perth suburbs within 7km of the city centre but outside the CBD were included in the category

(c) Middle suburbs: road links between 1,000m and 1.5km. Suburbs included were between 7km and 15km of the CBD

(d) Outer suburbs: road links greater than 1.5km. Suburbs were beyond 15km from the CBD [435]

For the purposes of this study, similar categories for used for postcodes. The first author of this report was contacted by email [436]. He stated that the categories were chosen based on the following factors: i) traffic intensity between 7am to 7pm; ii) roadside friction[50] and subsequent adjacent land use; and iii) quality of progress along roads [436]. The author advised that these categories were unlikely to change over an eight year period, so the same definitions were used throughout the study period.

Following discussion with an expert in GIS at the Department of Health [437], this categorisation was adapted further. Shapefiles of the road network and the controlled traffic signals of Perth Metropolitan Area were obtained from Main Roads Western Australia [438]. The distance between each traffic signal and its nearest neighbour was calculated in ArcGIS. This data was then used to calculate the median distance between traffic signals in each postcode and suburb. Each postcode and suburb was categorised purely according to the link distance described above (and not by distance from the CBD). This method of defining traffic zones attempted to account for other business and entertainment centres in the metropolitan area, such as Fremantle and Joondalup.

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[50] Roadside friction refers to the frequency of entrances such as driveway entrances along a road, and the impact this has on traffic operations.

Spatial autocorrelation

The concept of spatial dependence, and the effects it might have on the accuracy of aspatial models, has been discussed in detail in 3.9.4. To test for the presence of spatial autocorrelation in the model residuals and to formulate spatial models, it was necessary to construct a spatial weights matrix to define the interface between geographical units.

A spatial weights matrix is a matrix of n*n cells, where n = the number of spatial units (e.g. postcodes). If a spatial unit is adjacent to another spatial unit (that is, they are 'neighbours'), the position on the matrix is given the value one. If a spatial unit is not adjacent to another spatial unit, the position on the matrix is given the value zero. Thus a matrix of the relationships between each spatial unit and every other spatial unit is developed. Spatial weights matrices are frequently row-standardised, that is, if a spatial unit has five neighbours, each of the five neighbours has a weight of 1/5 (0.2) at the point of intersection with the spatial unit [439].

The method which is chosen to determine adjacency ('spatial conceptualisation') is important as it is used in three aspects of spatial modelling: i) diagnosing if spatial autocorrelation exists (e.g. calculating Moran's I); ii) deciding which type of spatial model to use; and iii) constructing the relevant spatial model. The two main ways of conceptualising spatial relationships are contiguity (spatial units share a border) and a distance band from the one spatial unit to the other. The method commonly used in alcohol outlet density literature is the queen's case[51] of first order contiguity: that is, polygons (spatial units) which share a border and/or an edge [440]. This method is used for the final model for total counts of outlets and sales per outlet per postcode.

There was no guidance in the alcohol literature about the conceptualisation of spatial relationships when using outlets and sales which fall in a buffer zone. It was decided to use a distance band method (i.e. including all outlets and their sales which fell within a certain distance from the postcode centroid). The distance used was the size of the buffer zone plus 5km. Five kilometres was chosen as it represented the size of the largest buffer zone used in the final analysis, and a high proportion of respondents in the online survey indicated that they would be prepared to travel this distance to purchase alcohol. An inverse distance band

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[51] The term 'queen's case' refers to the movement of the chess piece in any direction. Another type of continuity is the 'rook's case' referring to the movement of the rook or castle – it cannot move diagonally. Thus the edges of a polygon are considered adjacent when constructing the spatial weights matrix. Less common types are linear contiguity and Bishop's continuity [394] .

was used: the conceptual model of spatial relationship being of ‘impedance’, or ‘distance decay’ [440]. With this method, the impact of outlets and sales on risk of injury is modelled to decrease as distance from the postcode centroid increased.

Spatial weights matrices were constructed in ArcGIS, using the ABS shapefiles and the residuals from the negative binomial model with random effects with Night2 injuries as the dependent variable and counts and sales of on- and off-premise outlets, zone from the CBD and all socio-demographic variables as independent variables.

Postcodes with no neighbours (as determined by the relevant structure of the spatial weights matrix) and without residuals[52] from the negative binomial model with random effects were removed from the shapefile and a final spatial weights matrix was constructed accordingly. This was done separately for the models for the whole postcode and three buffer zones to create four different spatial weight matrices:

(a) For the models including all sales and outlets in a postcode (included 86 postcodes)

(b) For the models including all sales and outlets within 5km of the centroid of a postcode (included 91 postcodes)

(c) For the models including all sales and outlets within 2km of the centroid of a postcode (included 71 postcodes)

(d) For the models including all sales and outlets within 1km of the centroid of a postcode (included 48 postcodes)

In this study, Stata 12 was used to calculate the global Moran’s I, using the panel model residuals and spatial weights matrices created in ArcGIS. Although Moran’s I can also be calculated in ArcGIS, Stata was preferred because the statistic could be calculated simultaneously for each of several models, each using a different outcome variable or time period. Moran’s I was calculated for each of the four model types: total postcode, and outlets and sales within 5km, 2km and 1km from the postcode. Moran’s I was not calculated for the suburb models because there were no outlets and sales in many of the suburbs, making the statistic difficult to calculate and unreliable.

[52] The absence of a residual for an individual panel was usually because there was no alcohol sales data for that postcode or buffer zone.

Once it was established that spatial autocorrelation existed (indicted by a significant Moran's I statistic), testing was conducted in MATLAB[53] to establish what form of spatial model to develop. Lagrange Multiplier (LM) tests were conducted to check for: i) a spatially lagged dependent variable, and ii) spatial error autocorrelation, using the residuals of the non-spatial panel model. If both LM tests produced significant results, robust LM tests were conducted to choose between the two model types. These tested for existence of one type of spatial dependence (a spatially lagged dependent variable or spatial error autocorrelation) conditional on the other [386]. At the time of the analysis, no routines were available for spatial Durbin or general spatial models for panel data in MATLAB, so these models could not be tested.

The spatial models used were designed for panel data with continuous dependent variables (which assumed that the dependent variable followed a normal distribution), as opposed to the non-spatial negative binomial models with random effects which are appropriate for count dependent variables. At the present time, no routines for frequentist spatial panel models with count outcome variables have been developed, as spatial econometrics is a relatively new, developing field.

The only panel spatial models designed for count data with available code are Bayesian models which are run in the programs Winbugs or Openbugs [279, 441]. (The models in MATLAB and Stata are based on frequentist principles.) Although emerging Bayesian models for count models have been used in recent alcohol outlet density research (e.g. [279] [441]), the β coefficients in these models *"can be challenging to interpret"* [279] and are not comparable to the non-spatial negative binomial models with random effects, because of the different philosophy and assumptions underlying Bayesian statistics.

Despite the limitations of the models, the MATLAB frequentist routines were considered more appropriate and accessible. However the coefficients are not directly comparable, and so only the direction and significance of coefficients could be noted.

4.8 Ethical considerations

Ethical approval was obtained from the Human Research Ethics Committee at Curtin University on 10 November 2011 (Approval number HR 110/2011 – see Appendix 10.1)

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[53] MATLAB was used for these analyses as the routines for panel models are relatively well-developed, while the routines in Stata are very new (first published in January 2013) and still problematic.

The research predominantly involved the use of databases (except for the pilot study and panel survey). Ethical considerations specific to each phase of the project are discussed below:

4.8.1 Phase one

The Data Linkage Branch in the Department of Health of Western Australia (DOH) required approval by the Curtin University Human Research Ethics Committee prior to releasing the requested ED data. All personal health information obtained from the DOH was in the form of encrypted and non-identifiable electronic records. No identifying information was provided to the PhD student by the DOH. The statistical component of the study did not require identifiable information but used potentially re-identifiable data, with the encryption keys held by the DOH.

All data received from the DOH was collected, stored, used and disclosed according to the National Statement on Ethical Conduct in Human Research. The data was stored in a password-protected file that could be only be accessed by the student. Passwords were changed regularly. No data which could result in the identification of an individual were or will be used in any report or journal article arising from the use of the database. Results were aggregated so that no individual or specific community group could be identified, or will be identifiable in any future reports or articles produced.

4.8.2 Phase two

Written informed consent was obtained from participants in the pilot study. The purpose of the study was explained verbally and in writing, and the participants were given the opportunity to withdraw from the pilot survey. Written questionnaires were linked to individual participants by ID codes, known only to the student and each participant. These ID codes were required to link test and retest versions of the questionnaire and were stored in a password-protected file, accessible only by the student. The participants consented to providing group verbal feedback on the questionnaire. The necessity for confidentiality among group members was emphasised to participants [285].

Online survey participants remained anonymous. As a panel organiser was used, there was no contact with participants. Details about date of birth and address were not requested from participants: data was only collected on age (in years), gender, income category and postcode, and was not traceable to individual participants. By participating in the survey, consent was considered to be implied (see 2.2.5 and 3.1.17 of the National Statement on Ethical Conduct in Human Research [442]). Data files containing the results for both the pilot study and online survey contained only de-identified data, and only the student had access to it.

4.8.3 Phase three

Permission was granted by the DAO to access data on alcohol outlets and sales. The student signed a confidentiality agreement prior to accessing the alcohol sales data. As the data was sensitive, records relating to alcohol sales linked to postcodes and suburbs were only accessed on the NDRI secure server. Similarly, any data about outlet names, locations or extended trading hours permits which could be linked to alcohol sales were only accessed on the NDRI secure server. Only the student and members of the alcohol policy group at the NDRI had access to the sales data.

4.8.4 Phase four

Phase four involved the use of data discussed in Phases one to three above. All data was treated as discussed in Phase three.

All data retained in archives at the conclusion of the project will be encrypted, reduced to a minimum necessary for validation and stored for a period of five years at the National Drug Research Institute.

5 Results for Phase One: ED Data

This chapter describes the results obtained in Phase one of the project. The ED dataset is described in 5.1 and 5.2. In 5.3, the results of the validation process of the surrogate measure for ED alcohol-related injuries are detailed and the characteristics of the datasets of the preferred surrogate measures of alcohol-related injuries over the study period are outlined.

5.1 Overview of ED datasets

As discussed in Chapter four, the primary dataset was created containing ‘emergency’ Emergency Department presentations from 1 July 2002 to 30 June 2010. After removal of cases less than 15 years old and records missing data on age, gender, time of day or ICD-10 code, this dataset consisted of 1,600,669 cases (see Table 5.1 below). The dataset was further divided into wholly alcohol-attributable presentations (n=18,037) and all injury cases (n=485,551). While approximately 50% of all ED presentations were male, the wholly alcohol-attributable and injury datasets contained higher proportions of male cases (61% of the total for both subgroups of ED presentations). Similarly, young male presentations (those aged 15 to 24 years) constituted higher proportions of the wholly alcohol-attributable and injury presentations (16.1% and 20.8% respectively), compared to all ED presentations (11.1%).

Table 5.1: Summary table of demographic features of all ED, wholly alcohol-attributable and all injury cases presenting at Perth EDs from 1 July 2002 to 30 June 2010

ED cases[1]	Male		Young males (15 to 44 years)		Younger males (15 to 24 years)		Total	
	n	%[2]	n	%[2]	n	%[2]	n	%[2]
All ED	807,644	50	447,418	28	178,245	11	1,600,669	100
Wholly alcohol-attributable	10,945	61	7,352	41	2,896	16	18,037	100
All injury	294,109	61	217,020	45	101,060	21	485,551	100

[1]Includes emergency visits only [1]Includes emergency visits only; [2]percentage of total ED subset

Details about time periods relevant to the choice of a surrogate measure of alcohol-related injury are presented in Table 5.2 below. The dataset of wholly alcohol-attributable cases contained much higher proportions of night-time and weekend cases. Lower proportions of injury cases occurred at night-time, reflecting that most non-alcohol-involved injuries (which represent the majority of all injuries) present during the day-time hours [371].

Table 5.2: Summary table of time periods of all ED, wholly alcohol-attributable and all injury cases presenting at Perth EDs from 1 July 2002 to 30 June 2010

ED subset[1]	Night 2		Weekend[3]		Weekend (modified)[4]		Total	
	n	%[2]	n	%[2]	n	%	n	%[2]
All ED	192,355	12	728,188	45	612,448	38	1,600,669	100
Wholly alcohol-attributable	5,289	29	10,239	57	9,293	52	18,037	100
All injury	51,241	11	238,879	49	203,814	42	485,551	100

[1]Includes emergency visits only; [2]percentage of total ED subset; [3]Weekend: Thursday midnight to Sunday 11:59pm; [4]Weekend (modified): Friday 6pm to Monday 6:59am

5.2 Incidence Rate Ratios for all injuries

A negative binomial model was developed to calculate age- and gender-specific incidence rates for counts of all injuries presenting at Perth EDs, compared to non-injury ED presentations. The model allowed for clustering by postcode, because injury cases residing in the same postcode were likely to be more similar to each other than to injury cases living in other postcodes. Year of presentation, (modified) Weekend presentation, and time of day of injury were included in the model. The results are presented in Table 5.3 below. The risk of presentation at an ED for an injury (compared to a non-injury presentation) was 49% higher in males than females (IRR: 1.490; 95% Confidence Interval (CI): 1.458-1.523). The reference age group (15 to 24 year olds; n=147,681) were most at risk of presentation with an injury to an ED. The age group older than 44 years (category 3; n=160,898) were least at risk of presenting at an ED with an injury (IRR: 0.517; 95% CI: 0.506-0.528). Those presenting to an EDs at weekends had a 14.2% greater risk of presenting with an injury than those presenting at an ED on weekdays (95% CI: 1.131-1.154). Those presenting to an ED between midnight and 4:59am had a nearly 20% lower risk of presenting with an injury than those presenting at between 5am and 11:59pm (95% CI: 0.788-0.815).

Table 5.3: Negative binomial regression model of all injuries presenting at Perth EDs between 1 July 2002 and 30 June 2010

Predictors	IRR	95% CI	
2003/04[1]	1.024*	1.012	1.036
2004/05	1.034*	1.018	1.049
2005/06	1.008	0.990	1.026
2006/07	1.015	0.996	1.035
2007/08	1.003	0.982	1.023
2008/09	1.018*	1.001	1.036
2009/10	0.984	0.966	1.002
Night2[2]	0.801*	0.788	0.815
Weekend (modified)[3]	1.142*	1.131	1.154
Male[4]	1.490*	1.458	1.523
25 to 44 years[5]	0.789*	0.780	0.797
45+ years	0.517*	0.506	0.528

[1]Reference year: 2002/03; Reference time periods: [2]Day2 (7am to 9:59pm) and [3]Weekday (modified) (Monday 7am to Friday 5:59pm); [4] Reference gender: Female; [5]Reference age-category: 15 to 24 year olds [*] $p<0.05$

5.3 Surrogate measure validation

The methods used for the validation of the surrogate measure followed those used by Evans and colleagues [164] and are discussed in detail in 4.4.3. Using the potential surrogate measures proposed by Young [371], annual proportions of Perth ED cases were compared to proportions estimated from international sources (by Young et al.)[54] The Perth ED proportions were also compared with a South Australian (SA) ED sample (for 2009/10) [164]. South Australia has a similar climate to the Perth region and has a capital city with a similar population size and demographic profile (see Table 5.4 below).

The Perth data was analysed by financial year (1 July to 30 June) as the alcohol sales data used in Phases three and four of the project were provided in this format. For most candidate surrogate measures, proportions of alcohol-related injury were similar across Perth, SA and international EDs (Table 5.4 below).

The restricted age (young) injury surrogate[55], however, showed different patterns across the datasets: in the international dataset, this age-group accounted for more than 78% of the total injuries compared to proportions of 60% and 68% derived from Perth and SA EDs respectively. The SA ED study included a larger age range (15 to 44 years) in the cohort, while Young et al. included only those injury cases from 18 to 44 years old. Because the Perth study population was more similar to the South Australian population, this study used a similar age range to the SA ED study.

Approximately 50% of the data for the Young study came from the US. The differences in the proportion of young injuries between the ED datasets may be partly explained by different age structures between the two countries: the US had a higher proportion of 15 to 19 year olds compared to Australia at the time the ED data was sourced (7.2% in the US compared to 6.9% in Australia). Australia also had an older population than the US (24% of the Australian population over 55 years in the 2006 census, compared to 21% of the US population in the 2000 census [443, 444]. Furthermore, alcohol policies differ between Australia and the US (for example the minimum legal drinking age in Australia is 18, while in the US it is 21 years), and there are differences in mean price, per capital consumption, outlet densities and marketing between the two countries. These factors lead to different risk profiles among younger people in these countries.

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[54] This study included data from Fremantle Hospital in the southern Perth Metropolitan Area.
[55] Restricted Age Cohort for Perth and SA: 15 to 44 year olds; Young et al.: 18 to 44 year olds

Notably, each of the eight years of Perth ED data produced similar proportions of cases across the potential surrogate measures, indicating the reliability of the measures. The total number of all injuries rose from 43,044 in 2002/3 to 71,752 in 2009/10, representing an increase of 67%. This is explained partly by 17% increase in Perth's population between 2002/3 and 2009/10 [445], and partly by missing data from the Joondalup Health Campus between July 2002 and July 2004 (see 4.4.2). The increase could also be related to increased usage of EDs over the time period [406].

Table 5.4: Comparison of candidate surrogate measure for Emergency Department data, using Perth, South Australian and international data from 2002 to 2010

	Number and proportion of injury cases																					
	Perth ED data																SA ED data		Young *et al.* (international sample)		
	2002/3		2003/4		2004/5		2005/6		2006/7		2007/8		2008/9		2009/10		2009/10				Proportion consuming
Candidate surrogates	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	alcohol[6]
Injury cases	43,044	100	45,791	100	56,441	100	60,007	100	65,133	100	68,118	100	72,522	100	71,752	100	54,419	100	8,580	100	0.21
Restricted Age Cohort injuries[1]	28,146	65	30,470	67	37,633	67	40,067	67	43,784	67	45,909	67	48,632	67	47,228	66	32,820	60	6,701	78	0.24
Weekend[2] injuries	21,570	50	22,858	50	27,886	49	30,067	50	32,269	50	33,145	49	35,180	49	34,709	48	25,519	47	4,127	48	0.26
Weekend(modified)[3] injuries	18,555	43	19,657	43	23,921	42	25,561	43	27,572	42	28,175	41	29,920	41	29,389	41	-	-	-	-	-
Male injuries	25,839	60	27,586	60	33,951	60	36,465	61	39,727	61	41,827	61	44,117	61	43,528	61	31,947	59	5,400	63	0.28
Night1[4] injuries	9,540	22	9,877	22	12,112	21	12,425	21	13,601	21	14,161	21	14,905	21	13,668	19	10,624	20	1,823	21	0.46
Night1[4] Male injuries	6,072	14	6,243	14	7,702	14	7,952	13	8,701	13	9,123	13	9,391	13	8,669	12	6,549	12	1,275	15	0.55
Night1[4] Male Weekend injuries	3,389	7.9	3,475	7.6	4,336	7.7	4,623	7.7	5,001	7.7	5,314	7.8	5,376	7.4	5,006	7.0	3,689	6.8	748	8.7	0.6
Night1[4] Male Weekend restricted age cohort injuries	2,880	6.7	2,917	6.4	3,697	6.6	3,914	6.5	4,242	6.5	4,537	6.7	4,520	6.2	4,143	5.8	2,996	5.5	676	7.9	0.62
Night2[5] injuries	4,862	11	4,940	11	6,147	11	6,382	11	6,947	11	7,124	10	7,509	10	6,881	10	5,374	10	828	10	0.56
Night2[5] Male injury	3,196	7.4	3,212	7.0	4,049	7.2	4,254	7.1	4,543	7.0	4,775	7.0	4,912	6.8	4,524	6.3	3,433	6.3	603	7.0	0.66
Night2[5] Male Weekend injuries	1,998	4.6	2,015	4.4	2,555	4.5	2,756	4.6	2,892	4.4	3,111	4.6	3,141	4.3	2,979	4.2	2,129	3.9	404	4.7	0.69
Night2[5] Male weekend restricted age cohort injuries	1,766	4.1	1,738	3.8	2,230	4.0	2,429	4.0	2,523	3.9	2,760	4.1	2,724	3.8	2,546	3.5	1,814	3.3	378	4.4	0.71

[1]Restricted Age Cohort for Perth and SA: 15 to 44 year olds; Young et al.: 18 to 44 year olds; [2]Weekend: Friday/Saturday/Sunday; [3]Weekend (modified): Friday 6pm onwards, Saturday and Sunday, and Monday to 6:59am; [4]Night1: 10pm to 6:59am; [5]Night2: midnight to 4:59am; [6]Young et al. mean estimate for alcohol consumption in the last six hours prior to injury

The Pearson's Correlation Coefficient test was calculated to demonstrate the correlations between all ED presentations, wholly alcohol-attributable cases and injury cases for each time period. (The effects of age and gender are not accounted for in these comparisons.) Results are shown in Table 5.5.

Table 5.5: Pearson's Correlation Coefficient tests comparing various categories of ED presentations at Perth ED between 1 July 2002 and 30 June 2010

	Wholly alcohol ED cases	All ED cases	Night2 injuries	Weekend day2 injuries	Weekend night2 injuries	Weekday day2 injuries	Weekday night2 injuries	Weekend (modified) injuries	All injuries
Wholly alcohol ED cases	1								
All ED cases	0.65	1							
Night2[1] injuries	0.63	0.80	1						
Weekend[2] Day2 injuries	0.62	0.89	0.73	1					
Weekend[2] Night2[1] injuries	0.57	0.74	0.87	0.75	1				
Weekday Day2 injuries	0.66	0.95	0.83	0.85	0.74	1			
Weekday Night2[1] injuries	0.49	0.60	0.82	0.46	0.44	0.66	1		
Weekend (modified)[3] injuries	0.64	0.89	0.79	0.99	0.83	0.86	0.48	1	
All injuries	0.68	0.96	0.86	0.93	0.80	0.98	0.65	0.94	1

[1]Night2: midnight to 4:59am; [2]Weekend: Friday/Saturday/Sunday;
[3]Weekend (modified): Friday 6pm onwards, Saturday and Sunday, Monday to 6:59am

5.3.1 Comparing wholly alcohol-attributable cases with all injury cases

The temporal distribution of wholly alcohol-attributable cases was compared to the temporal distribution of all injury cases for Perth for the financial years from 2002 to 2010 (Figure 5.1). The proportion of wholly alcohol-attributable cases reached a peak between 10pm and 4am. All injury cases plateaued between 9am and 6pm. The difference in the temporal patterns between the two datasets highlighted the small number of wholly alcohol-attributable injury cases (which had little influence on the overall temporal pattern of all injury cases) and the unsuitably of ‘all injuries’ as a surrogate measure of alcohol-related injury. Young et al. demonstrated that daytime injuries, while more numerous, consisted of a low proportion of cases involving alcohol [168].

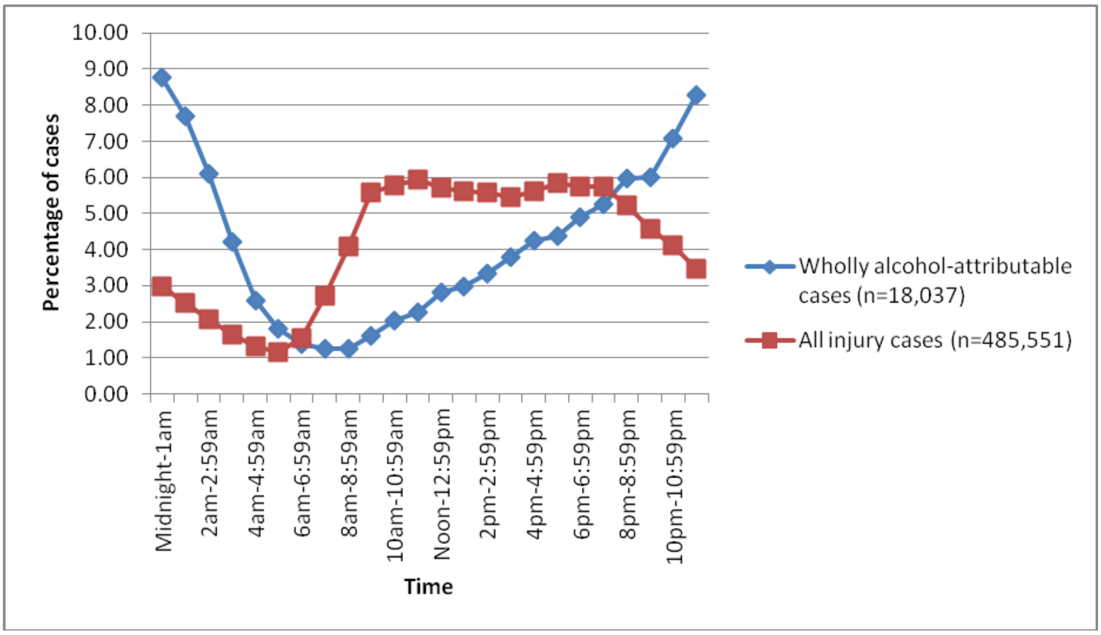

Figure 5.1: The temporal distribution of wholly alcohol-attributable cases vs injury cases at Perth EDs between 2002/3 and 2009/10

5.3.2 Comparing a highly alcohol specific surrogate to all wholly alcohol-attributable cases

The temporal distribution of 15 to 44 year old male weekend wholly alcohol-attributable cases and injury cases were compared to that of all wholly alcohol-attributable cases and all injury cases. The distribution of 15 to 44 year old male weekend wholly alcohol-attributable cases followed a similar pattern to all injury cases, but demonstrated a higher night-time peak. The distribution of younger male weekend night-time injury cases contained a larger proportion of cases in early evening and during the night-time hours than all injury cases and is a highly specific surrogate measure of alcohol-related injury: a high proportion of these cases consume alcohol [164, 371]. Although it is highly specific, it is less sensitive and includes only a small proportion of all ED injury cases (Table 5.4 and Figure 5.2).

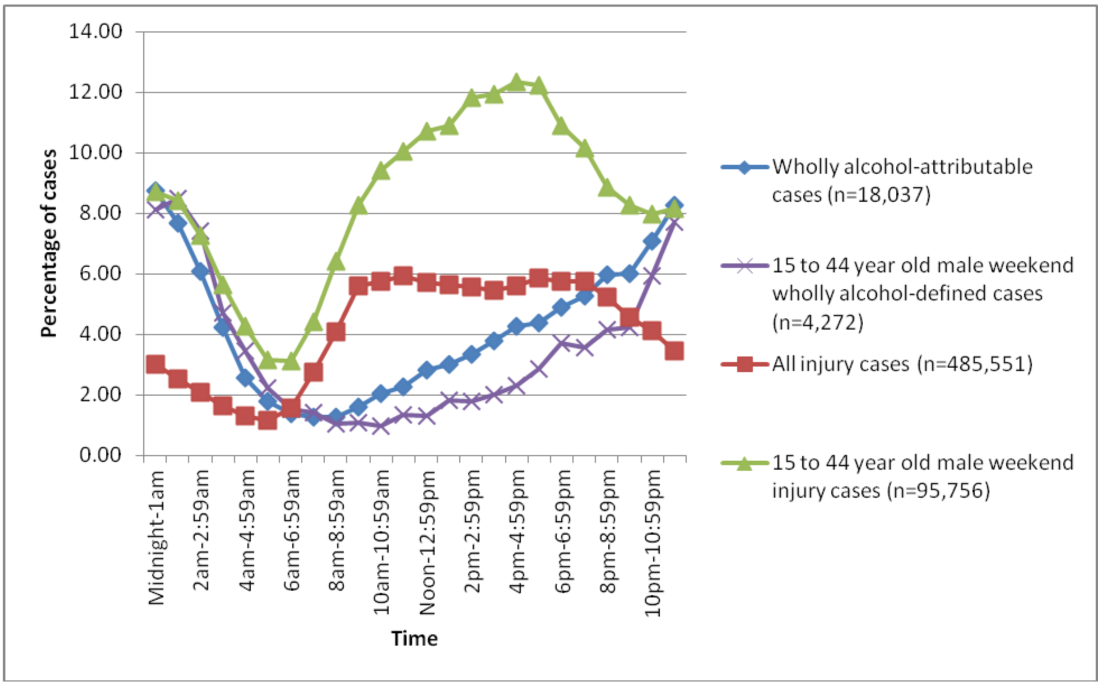

Figure 5.2: Comparison of the temporal distribution of young male weekend injury and wholly alcohol-attributable cases with all injury and all wholly alcohol-attributable cases at Perth EDs from 2002/3 to 2009/10

5.3.3 Comparing candidates for time-based control surrogate measures

The number of injury cases presenting at Perth EDs were compared across three time periods during which injuries were unlikely to have been alcohol-related (see Table 5.6). Young and colleagues have shown that all three potential control surrogates included relatively low proportions of alcohol-attributable cases, i.e. between 15% and 18% [371].

Weekday cases comprised a relatively low proportion of all injury cases (around 50%, Table 5.6) although this time period contained most of the hours in the week. Both Day1 (7am to 9:59pm) and Day2 (5am to 11:59pm) included high proportions of all injury cases (approximately 80% and 90% respectively) but the Day1 time period excluded the time period from 10pm to midnight, when a high proportion of alcohol-involved cases present at EDs (see Figure 5.1 and [164]). It therefore represented a better measure of injury which did not involve alcohol.

Table 5.6: Comparison of injury cases across time periods with low proportions of alcohol-related cases, in Perth EDs from 1 July 2002 to 30 June 2010

Candidate surrogate controls	Weekday[1] injuries		Day1[2] injuries		Day2[3] injuries		Total injuries
Perth EDs	n	%	n	%	n	%	n
2002/3	21,474	50	33,504	78	38,182	89	43,044
2003/4	22,933	50	35,914	78	40,851	89	45,791
2004/5	28,555	51	44,329	79	50,294	89	56,441
2005/6	29,940	50	47,582	79	53,625	89	60,007
2006/7	32,864	50	51,532	79	58,186	89	65,133
2007/8	34,973	51	53,957	79	60,994	90	68,118
2008/9	37,342	51	57,617	79	65,013	90	72,522
2009/10	37,043	52	58,084	81	64,871	90	71,752
International EDs	4,453	52	6,757	79	7,752	90	8,580
South Australia: 2009/10	27,529	51	41,287	76	46,433	85	54,419
Proportion consuming alcohol[4]	0.17		0.15		0.18		0.21

[1]Weekday: Monday to Thursday; [2]Day 1: 07:00 to 9:59pm; [3]Day 2 5am to 11:59pm;
[4]Young *et al*. mean estimate that alcohol was consumed 6 hours before injury

5.3.4 Combining hour of day and day of week surrogate measures

The proportion of weekend[56] only wholly alcohol-attributable cases was compared to all wholly alcohol-attributable cases. The temporal pattern was similar between the two surrogate measures (Figure 5.3); however, it appeared that higher proportions of weekend only cases presented at night (particularly between the hours of 10pm and 3am) compared to the ‘all week’ wholly alcohol-attributable cases. Young et al. [371] did not calculate the expected proportion of alcohol-involved cases for a combined night-time, weekend surrogate, making further comparisons with other candidate surrogate measures impossible.

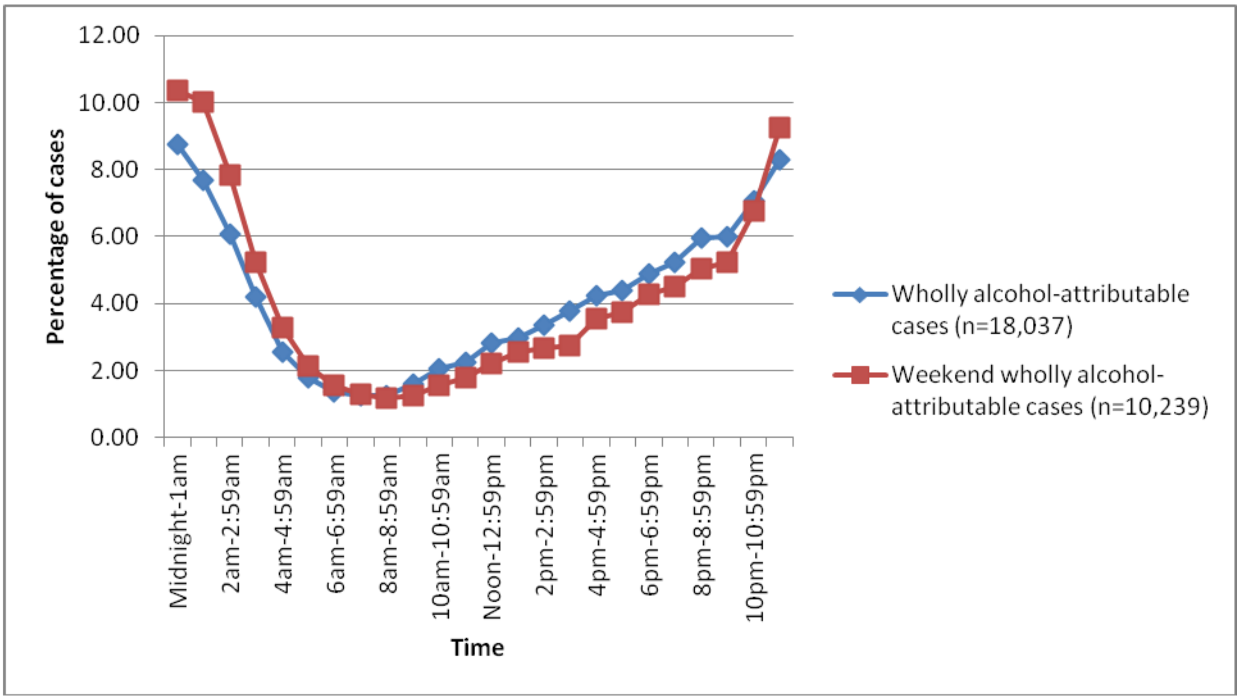

Figure 5.3: Comparison of the temporal distribution of weekend and all day wholly alcohol-attributable cases presenting at Perth EDs between 2002/3 and 2009/10

5.3.5 Summary of validation of surrogate

The preferred surrogate identified by Evans et al. [164] was the ‘Night2’ period, from midnight to 4:49am. This surrogate included between 9% and 12% of all injury cases (ranging from 4,862 cases in 2002/3 to 6,881 cases in 2009/10 at Perth EDs). The ‘Night1’ period, from 10pm to 6:59am, incorporated a higher proportion of all injury cases occurring at Perth EDs (approximately 21% between 2002/3 and 2009/10). However, based on the data presented by Young et al. [168], the proportion of alcohol-involved cases would be lower than during the Night1 time period than the Night2 period (i.e. 46% vs 56%), making the Night2 period a more specific surrogate measure of alcohol-related injury [371].

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[56] Weekend refers to Friday, Saturday and Sunday in this context.

Weekend injuries contributed nearly 50% of injury cases but were of lower specificity (only 26% of cases were alcohol-related [168]). The group of Weekend Night2 injuries contributed approximately 6.4% of all injury cases (29,921 cases between mid-2002 and mid-2010).

As advocated by Chikritzhs et al. [183] and Evans et al. (p. 65 [164]), and in 4.4.3 of this thesis, Young and colleagues' definition of 'Weekend' did not adequately capture alcohol-related injuries associated with weekend drinking, since it included Friday morning and excluded Monday morning presentations. A better definition of Weekend was proposed: 6pm on Friday to Monday at 6:59am. This is referred to as 'Weekend (modified)' in Tables 5.2 and 5.5. Both Weekend (modified) Night2 (Saturday, Sunday and Monday from midnight to 4:59am and Weekend Night2 (Friday, Saturday and Sunday from midnight to 4:59am) consisted of 15 hours. Weekend (modified) Night2 included 29,048 injury cases (6.2% of injury cases).

The higher specificity of the Weekend Night2 indicator made it a satisfactory choice for a surrogate measure of alcohol-related injury in this study. However, the proportion of alcohol-involved cases was not ascertained by Young et al. [371] nor was the definition of Weekend used in the study as specific as the Weekend (modified) definition discussed above. Because of these limitations, the all week Night2 surrogate was used as the primary surrogate - a less specific proxy but with a known proportion of alcohol-involved cases - and Weekend (modified) Night2 injury was used as a second proxy for alcohol-involved injury.

5.3.6 Descriptive statistics for the preferred surrogate measures of alcohol-related injury

A comparison between the chosen surrogate measures - Night2 cases (midnight to 4:59am) and Weekend (modified) Night2 cases (midnight to 4:59am on Saturday, Sunday and Monday mornings) - and all injuries is presented in Table 5.7 below.

Males made up more than 60% of all injuries, but this proportion was higher in the Night2 period and even higher over the same hours on the weekend (nearly 66% and 68% respectively). The mean age was highest in the all injury group, and dropped in the Night2 and Weekend Night2 groups (34 and 32 years old respectively). These findings supported Young and colleagues' results, which indicated that higher proportions of males and those less than 45 years of age consumed alcohol in the six hours prior to injury [371]. Furthermore, other international ED research has shown greater involvement of alcohol in injuries occurring in males and younger cases (e.g. [99, 122, 124, 446].

A much higher proportion of Indigenous cases presented during the Night2 time period (25.42%) compared to all week (3.32%). The proportion of Indigenous cases was only slightly higher for Weekend Night2 injuries (4.89%) compared to all week. This suggests that relatively more Australians of Indigenous origin in Perth present at EDs during the weekday nights. The reason for this is unknown. Slightly higher proportions of urgent presentations (triage categories one and two) presented during Weekend and Night2 periods. It is not known, however, if this difference was significant.

Table 5.7: Breakdown of demographic characteristics and triage categories of injury cases by surrogate measures, presenting at Perth EDs between from 1 July 2002 to 30 June 2010

Injury cases	All		Night2[1]		Weekend Night2[2]	
	n	%	n	%	n	%
Gender						
Male	294,109	61	33,651	66	20,747	68
Female	191,442	39	17,590	34	9,935	32
Age						
Mean age	39	0.01	34	0.07	32	0.10
% Young male (15-24 years)	101,060	21	14,819	29	10,389	34
Indigenous Status						
Indigenous	16,101	3.3	13,027	25	1,500	4.9
Not indigenous	51,704	11	44,549	87	26,823	87
Triage Category						
Category 1	5,586	1.2	959	1.9	616	2.0
Category 2	38,545	7.9	5,056	9.9	2,993	9.8
Category 3	127,697	26	15,457	30	9,337	30
Category 4	280,593	58	27,855	54	16,679	54
Category 5	33,125	6.8	1,914	3.7	1,057	3.5
Total cases	485,551	100	51,241	100	30,682	100

[1]Night2: midnight to 4:59am; [2]Weekend (modified) Night2: Friday midnight to 4:59am

5.4 Summary

This chapter presented an overview of the ED datasets and the validation process for a surrogate measure of alcohol-related injury. The validation process showed the Perth ED data followed similar temporal and demographic trends to the South Australian ED data [164] and the international ED dataset [168]. Two surrogate measures were chosen for use in Phase four of the project: Night2 injuries and Weekend (modified) Night2 injuries.

6 Results for Phase Two: Online Survey

This chapter describes the results obtained from the online survey of purchasing behaviour of Australians living in capital cities (Phase two of the project). A pilot study was undertaken prior to the online survey to test the questionnaire and is described in 6.1, together with modifications made to the questionnaire following the pilot study. In 6.2, the demographic and socio-economic characteristics of the online survey sample are described, the sample is compared to that of the National Drug Strategy Household Survey, and the results of the online survey are presented.

6.1 The Pilot study

The pilot survey was administered as a written questionnaire to residents of Perth on two occasions (Appendix 10.4). After participants completed the questionnaire at the baseline assessment, they gave feedback on the questionnaire.

The survey was piloted, in November and December 2011, on 38 residents of Perth (15 males and 23 females) aged between 18 and 82 years (mean age = 36, standard deviation (SD) = 16.6). Four group sessions were conducted, varying in size from six to thirteen participants. A research assistant assisted in the organisation and administration of the questionnaires for the three largest groups. Three other participants answered the questionnaire individually. The time taken by the participants was monitored: the mean time taken to complete the questionnaire was 13 minutes (SD = 3.4).

Participants of the three largest groups were then asked to provide group verbal feedback on the interpretability of the surveys. The discussion was guided by a list of questions. Participants' feedback was recorded by both the student and the research assistant. Individual participants and those in the smallest group completed written feedback, by answering the same questions used to guide the group discussions.

Of the 38 participants, 35 participants completed the questionnaire twice, providing test-retest data (to measure the reliability of the questionnaire). In addition, 31 participants later provided data on actual purchasing behaviour since completing the survey, which tested the validity of the questionnaire.

6.1.1 Results of pilot study

Group Feedback

Group feedback from the participants indicated the following: participants generally found instructions about completion of the questionnaire easy to follow. On the whole, participants found most questions easy to understand and unambiguous, but certain participants indicated that a few questions which were less clear. These questions were reviewed and clarified for the online survey.

In the questionnaire, participants were asked how much further they would travel for a 10% or 50% discount on different alcoholic beverages. More than 60% of participants said they would travel no further for a 10% discount at a liquor store or restaurant. For a 50% discount on liquor price, however, most participants were prepared to travel further - only 23% and 26% of participants were not prepared to travel further for a 50% discount at a liquor store and restaurant respectively. In the group discussions, several participants stated that a 10% discount was insufficient motivation to travel much further. Participants agreed that a 20% discount was more likely to change their purchasing behaviour, and that a 30 to 35% discount was sufficiently large to change how far they travelled to purchase alcohol. Consequently, the final questionnaire used four discount levels: 10%, 25%, 30% and 50%. A further three questions on the effect of a 10% discount on volume of purchases was not completed by most participants, and so were removed from the final questionnaire.

Most participants found the questions relating to purchases at restaurants and cafes difficult to answer. Participants felt that the price of alcohol was not the primary reason to choose a restaurant. More important reasons for selecting a restaurant included: type and quality of food; price of food; and special occasions e.g. a friend's birthday to be held there. However, whether a restaurant allowed 'BYO' (bring your own alcohol) influenced the choice of a restaurant, especially among participants under the age of 30 years. These participants were more likely to choose a restaurant allowing BYO, and would consume more alcohol than if they were required to purchase alcohol directly from the restaurant. Participants stated that this was because of the price differential between liquor stores and restaurants.

One participant suggested adding a 'less than 2km' category to questions about distance. This suggestion was later used when choosing the size of buffer zones for analysing the data in Phase four. Furthermore, the order of questions was altered, based on the student's observations and comments by participants, to improve the flow of the questionnaire.

Reliability and validity of the questionnaire

Using Cohen's kappa coefficient, the answers of the test and retest completions of the questionnaire were compared for 35 participants. By calculating the kappa coefficient, the degree of agreement between the initial completion and retesting of a question can be assessed [447]. A weighted kappa coefficient was calculated for those questions where the degree of disagreement between categories was important [448], for example, ordered questions about increasing distances travelled to purchase alcohol. For questions in which the level of disagreement between answers was not important, unweighted kappa coefficients were calculated. Certain questions, for example about gender and postcode of residence, were not tested.

The results of those questions tested are in Appendix 10.5. Scores ranged from 0.23 to 0.92[57]. Questions with kappa scores of over 0.81 (almost perfect agreement [449]) included those about frequency of drinking, and higher (50%) discounts at nightclubs and liquor stores. Those questions about lower discounts to prices (10%) produced less agreement between the two completions of the questionnaire. Questions about distances travelled and the effects of discounts on restaurant purchases had low kappa scores; this was understandable considering the multiple factors which contributed to participants' choice of restaurants. Questions with the option of choosing multiple answers had low kappa scores, because the test could not accommodate several responses by one participant. In summary, the reliability tests supported the results of the group discussion by participants, but suggested that the size of hypothetical discounts needed to be adjusted and the reasons for purchasing decisions on restaurants needed to be explored further. This concurred with the group discussions.

To check the validity of the distance questions, participants were contacted by telephone or email (depending on their preferred media of communication) approximately 10 days after the questionnaire was redone and asked the following questions:

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[57] Kappa <0: no agreement
0-0.20: slight agreement
0.20-0.40: fair agreement
0.41-0.60: moderate agreement
0.61-0.80: substantial agreement
0.81-1: almost perfect agreement [449]

"Have you bought alcohol in the last 10 days? If so, how far did you travel to buy it:

(a) at a liquor store

(b) at a nightclub/hotel

(c) at a restaurant"

Useable responses were obtained from 31 of the 38 participants. The seven remaining participants were either on holiday (i.e. away from Perth) or had not purchased alcohol when contacted (more than once). Relatively few participants had visited restaurants or nightclubs over the intervening time (10 and 8 participants respectively). Twenty-nine of respondents had purchased alcohol from a liquor store. A total of 24 of these 29 respondents had purchased alcohol in the same distance category (0 to 10km, 10 to 20km or 20 to 50km) as they recorded on their questionnaires. Therefore, the agreement between the questionnaire and actual purchasing behaviour was nearly 83%. This was considered acceptable.

Modifications were made to the questionnaire based on comments by pilot study participants. The questionnaire was then reviewed by the PhD student and her supervisors, and further modifications were made. A panel of experts was consulted about the wording of questions and flow of the questionnaire. Based on their recommendations, further modifications were made to the instructions, questions and the length of the questionnaire. Finally, the questionnaire was completed by three people experienced in the design of alcohol surveys and their comments noted. The final questionnaire (Appendix 10.8) was then submitted to the organisation that ran the online survey.

6.2 Online survey

The online survey was successfully completed by 831 participants: 405 (49%) males and 426 (51%) females (Table 6.2). The participants ranged in age from 18 to 88 years of age, with a mean age of 44.2 years and a standard deviation (SD) of 15.4. The age distribution (in five year age categories) is shown below in Table 6.1.

Table 6.1: Distribution of age categories in the national online survey in Australian capital cities[1] in 2012

Age	n	%
18 to 19	22	2.6
20 to 24	76	9.1
25 to 29	84	10
30 to 34	83	10
35 to 39	94	11
40 to 44	75	9.0
45 to 49	80	9.6
50 to 54	82	9.9
55 to 59	70	8.4
60 to 64	60	7.2
65 to 69	68	8.2
70 to 74	25	3.0
75 to 79	10	1.2
80 plus	2	0.24
Total	831	100

[1]The Australian Capital cities included in the survey were Perth, Sydney, Melbourne, Brisbane, Adelaide and Hobart.

Nine (1.1%) participants were of Aboriginal origin (Table 6.2). One participant was of both Aboriginal and Torres Strait Island descent. The remaining 821 (98.8%) participants were not of Indigenous origin. A total of 495 (59.6%) of participants were married or co-habiting couples, while 222 (26.7%) participants had never married. The remainder of the sample were widowed, separated or divorced (n=114, 13.7%). Australian born participants comprised 594 (71.4%) of the sample. Participants with other countries of origin with a large representation in the sample were born in: the United Kingdom (95 - 11%); New Zealand (14 - 1.7%); and Malaysia (9 - 1.1%). The majority of the participants had household incomes less than $100,000 (551 – 66.3%). Most of the sample resided in Victoria (203 – 24.4%), South Australia (193 - 23.2%), New South Wales (185 – 22.3%) and Western Australia (129 – 15.5%). The sample contained residents across all SEIFA quartiles (24% to 26% in each quartile).

Table 6.2: Demographic and socio-economic characteristics of participants in the national online survey in Australian capital cities[1] in 2012

Sample characteristics	n	%
Gender		
Male	405	49
Female	426	51
Indigenous status		
No	821	99
Yes, aboriginal	9	1.1
Yes both Aboriginal and Torres Strait Islander	1	0.12
Marital status		
Never married	222	27
Widowed	23	2.8
Divorced	71	8.5
Separated	20	2.4
Married (inc co-habiting)	495	60
Country of birth		
Australia	594	71
United Kingdom	95	11
New Zealand	14	1.7
Malaysia	9	1.1
Other	119	14
Household income		
<$50,000	224	27
$50,000 to $74,999	166	20
$75,000 to $99,999	161	19
$100,000 to $149,999	184	22
$150,000 to $199,999	68	8.2
>$200,000	28	3.4
Capital city		
Canberra	3	0.36
Sydney	185	22
Brisbane	102	12
Adelaide	193	23
Hobart	16	1.9
Melbourne	203	24
Perth	129	16
SEIFA quartiles		
1	202	24
2	203	24
3	207	25
4	219	26

[1]The Australian Capital cities included in the survey were Perth, Sydney, Melbourne, Brisbane, Adelaide and Hobart

6.2.1 Comparison to National Drug Strategy Household Surveys

The National Drug Strategy Household Survey was used to check the generalisability of the online survey results to the rest of the Australian population. The National Drug Strategy Household Survey (NDSHS) is a nationally representative population survey, conducted every three years, which provides data on alcohol, tobacco and other drug use. Including the 2010 survey, ten surveys have been conducted since 1985 of which the latter five have been conducted by the Australian Institute of Health and Welfare [450].

The NDSHS for 2007 and 2010 were used as benchmarks to compare: i) frequency of drinking (Tables 6.3 and 6.4 - proportions weighed for the same populations as the NDSHS surveys) and ii) preferred alcoholic beverage (Table 6.5 – 2010 survey only as data not available in 2007 survey). The 2007 NDSHS had 23,356 participants (nearly 16% of these were abstainers aged 18 or more) [416]. The 2010 NDSHS surveyed 29,356 participants (nearly 18% of those over the age of 18 were abstainers) [451]. Abstainers and those under 18 years in the NDSHS were excluded from this comparison, because all online survey participants were current drinkers aged 18 years or older. The absolute numbers of NDSHS respondents in each category were not available so percentages were used in the comparison.

Results

The online survey contained a higher proportion of daily drinkers compared to the participants in the NDSHS – significantly different among male drinkers (19.8% compared to 10.3% in 2010, see Table 6.4).

Table 6.3: Comparison of the frequency of drinking between participants of the 2007 National Drug Strategy Surveys and the 2012 online survey in Australia

	Males (%)		Females (%)		Persons (%)	
	NDSH survey[1]	Online survey[2]	NDSH survey[1]	Online survey[2]	NDSH survey[1]	Online survey[2]
Year of survey	2007	2012	2007	2012	2007	2012
Frequency of drinking						
Daily	11*	19	7.9*	16	9.8*	18
Weekly	49	53	52	46	50	49
Less than once a week	40*	27	41	38	40*	33
Total drinkers	100	100	100	100	100	100

Table 6.4: Comparison of the frequency of drinking between participants of the 2010 National Drug Strategy Surveys and the 2012 online survey in Australia

	Males (%)		Females (%)		Persons (%)	
	NDSH survey[1]	Online survey[3]	NDSH survey[1]	Online survey[3]	NDSH survey[1]	Online survey[3]
Year of survey	2010	2012	2010	2012	2010	2012
Frequency of drinking						
Daily	10*	20	7.2*	16	8.9*	18
Weekly	48	53	50	46	49	49
Less than once a week	41*	27	43	38	42*	33
Total drinkers	100	100	100	100	100	100

[1]NDSH survey is the National Drug Strategy Household Survey
[2]Online survey proportions were corrected for the proportion by age and gender of the 2007 Australian estimated resident population from the ABS [3]Online survey proportions were corrected for the proportion by age and gender of the 2010 Australian estimated resident population from the ABS
*Significantly different to online survey results ($p<0.0001$)

On the whole, the online survey conducted in 2012 and NDSHS participants' alcoholic beverage preferences were similar for males and females. The exception was in the 18 to 19 year old group, where the most popular beverage was spirits (with or without a mixer) for the online survey, and pre-mixed spirits for the NDSHS (see Table 6.5). This difference may be the result of varying definitions of straight versus premixed spirits across the surveys, or influenced by the small number of participants in this two year age group: only 22 participants in the online survey.

Table 6.5: Comparison of the main type of alcohol usually consumed by participants of the 2010 National Drug Strategy Survey and the 2012 online survey in Australia

Age (years)	2010 NDSH survey[1]		2012 Online survey[2]	
	Alcohol type	%	Alcohol type	%
18 to 19	Pre-mixed spirits	36.20	Bottled spirits	48.51
20 to 29	Regular strength beer	27.40	Regular strength beer	24.73
30 to 39	Bottled wine	33.40	Bottled wine	27.12
40 to 49	Bottled wine	37.60	Bottled wine	30.88
50 to 59	Bottled wine	41.40	Bottled wine	36.38
60+	Bottled wine	39.70	Bottled wine	59.40
All male	Regular strength beer	34.30	Regular strength beer	34.23
All female	Bottled wine	48.90	Bottled wine	44.09
Total	Regular strength beer	33.50	Bottled wine	46.03

[1]NDSH survey is the National Drug Strategy Household Survey
[2]Total online survey proportion corrected for the proportion by age and gender of the 2010 Australian estimated resident population from the ABS

6.2.2 Other factors influencing location of purchase of alcohol

Table 6.6 below shows the most common forms of transport used by online survey participants when purchasing alcohol. Participants were asked to mark *all* modes of transport that they used. The most common mode of transport used was driving a car: nearly 88% (730) of participants commonly used this. Walking was the second most commonly used most of transport (n=162, 20%).

Table 6.6: Mode of transport used by online survey participants to purchase alcohol, in Australian capital cities in 2012

Transport type	n	%
Walk	162	19
Car	730	88
Bicycle	20	2.4
Motorbike	10	1.2
Public Transport	49	5.9
Other[1]	24	2.9
Total number	831	100

[1] 'Other' included being driven by someone else, internet orders and home delivery

Participants were asked what influenced their choice about where to purchase alcohol. Participants rated a list of nine factors with 1 being most important and 9 being least important. A weighted index was then created of these factors[58]. The lowest index score represented the most important (highest rated) factor influencing choice about where to purchase alcohol (see Table 6.7). The most important factors affecting the location at which participants purchase alcohol were price of drinks (2.54) and closeness to home (2.89). Proximity to a shopping centre (4.5), variety of drinks available (4.6) and opening hours (4.9) were also influential in choice of where to buy alcohol. These results confirmed the importance of economic and physical availability (i.e. price and proximity) in consumers' purchasing decisions. Other factors named by individual participants as influencing their purchasing decisions were: bulk discount deals and advertised specials, staff service and knowledge of wine, the range of drinks, availability of preferred brands, easy parking and short queues, the opportunity to use a rewards card, and proximity to the event for which alcohol was being purchased.

[58] All the ratings (1 to 9) for all participants were added together for each of the nine factors. Each total was then divided by the number of participants to create an index for each factor.

Table 6.7: Factors affecting choice of location for purchasing alcohol by participants of the online survey, in Australian capital cities in 2012

Factors affecting purchasing location#	Index
Price of drinks	2.5
Closeness to home	2.9
Close to shopping centre	4.5
Variety of drinks available	4.6
Opening hours	4.9
How busy or tired I am	5.2
On route between work and home	5.9
Closeness to work	7.2
Price of petrol	7.3

Lowest index value indicates the most important factor

6.2.3 The influence of distance on purchasing behaviour

Participants were asked how far they were prepared to travel in order to purchase alcohol. They were given six options: less than 5km; 5km to 9km; 10km to 19km; 20 to 50km; more than 50km; and that distance did not influence where alcohol was purchased. This question was asked for each of the five most common licence types. The results informed the choice of buffer zones used in the analysis in phases three and four of the project.

6.2.4 Off-premise purchases

Bottle shop

A total of 681 of the online survey participants had purchased alcohol from a bottle shop in the last 12 months (male: n=342, 50%; 18 to 24 year olds: n=81, 12%). Results of distances participants were prepared to travel to purchase alcohol at a bottle shop are shown in Table 6.8 below. Approximately half of the male (n=175) and female (n=164) participants were prepared to travel less than 5km to a bottle store. Female participants were more likely to travel slightly further than male (12% of females would travel 10 to 19km, compared to 6.4% of males. The youngest group of drinkers (18 to 24 years old) were usually prepared to travel further than other age-groups (54% would travel 5km to 19km, compared to less than 45% of the other age groups). Drinking frequency did not appear to affect the distance that drinkers were prepared to travel to purchase alcohol. A higher proportion of those in the higher SEIFA levels (that is, higher postcode level socio-economic status) usually travelled less than 5km to purchase alcohol from a bottle shop. None of the participants usually travelled more than 50km to purchase alcohol from a liquor store. Since this survey only used participants living in capital cities, this is unsurprising, because of probable location of bottle shops much closer than this.

Table 6.8: Distance that online survey participants were prepared to travel to purchase alcohol at a bottle shop, by socio-demographic factors, in Australian capital cities in 2012

Distance	Less than 5km	5km to 9km	10km to 19km	20km to 50km	More than 50km	Other[1]	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gender							
Male	175 (51)	127 (37)	22 (6.4)	4 (1.2)	0 (0)	14 (4.1)	342 (100)
Female	164 (48)	121 (36)	39 (12)	4 (1.2)	0 (0)	11 (3.2)	339 (100)
Age							
18 to 24 years	30 (37)	34 (42)	10 (12)	3 (3.7)	0 (0)	4 (4.9)	81 (100)
25 to 44 years	152 (52)	103 (36)	21 (7.2)	4 (1.4)	0 (0)	10 (3.5)	290 (100)
45 years+	157 (51)	111 (36)	30 (9.7)	1 (0.30)	0 (0)	11 (3.6)	310 (100)
Drinking frequency							
Daily	59 (51)	42 (36)	9 (7.8)	0 (0)	0 (0)	6 (5.2)	116 (100)
Weekly	170 (49)	129 (37)	31 (8.9)	6 (1.7)	0 (0)	11 (3.2)	347 (100)
Less than weekly	110 (50)	77 (35)	21 (9.6)	2 (0.9)	0 (0)	8 (3.7)	218 (100)
SEIFA							
1	78 (50)	57 (36)	15 (9.5)	2 (1.3)	0 (0)	6 (3.8)	158 (100)
2	76 (45)	66 (39)	17 (10)	3 (1.8)	0 (0)	6 (3.6)	168 (100)
3	92 (53)	60 (35)	12 (6.9)	1 (0.60)	0 (0)	8 (4.6)	173 (100)
4	93 (51)	65 (36)	17 (9.3)	2 (1.1)	0 (0)	5 (2.8)	182 (100)
Total	339 (50)	248 (36)	61 (9.0)	8 (1.2)	0 (0)	25 (3.7)	681 (100)

[1]Other: distance did not influence the decision about where to purchase alcohol

Supermarket liquor store

A total of 605 of the online survey participants had purchased alcohol from a supermarket liquor store in the last 12 months (male: n=294, 49%; 18 to 24 year olds: n=70, 12%). Results of distances participants were prepared to travel to purchase alcohol at a supermarket liquor store are shown in Table 6.9 below. Slightly more male participants (n=165, 56%) than female participants (n=166, 53%) were prepared to travel less than 5km to a supermarket liquor store, while a higher proportion of females were prepared to travel 5km to 9km to purchase alcohol. Those aged 18 to 24 years were prepared to travel further than the older age groups, with nearly 18% of the youngest group prepared to travel 10km or more to purchase alcohol, compared to less than 9% of those aged 25 to 44 years – these differences were significant. Distance travelled to purchase alcohol did not appear to vary substantially by drinking frequency, although fewer of those drinking weekly were prepared to travel further to purchase alcohol. Those in SEIFA level two (the second lowest socio-economic group) had the lowest proportion of drinkers prepared to travel less than 5km to access alcohol, and the highest proportion prepared to travel 5km to 9km. This possibly reflected higher access to private motor vehicles compared to those in the lowest SEIFA level, but a greater need to search for lower prices than those in the higher SEIFA levels (as shown by discounting behaviour, 6.2.6).

Table 6.9: Distance that online survey participants were prepared to travel to purchase alcohol at a supermarket liquor store, by socio-demographic factors, in Australian capital cities in 2012

Distance	Less than 5km	5km to 9km	10km to 19km	20km to 50km	More than 50km	Other[1]	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gender							
Male	165 (56)	91 (31)	22 (7.5)	2 (0.68)	0 (0)	14 (4.8)	294 (100)
Female	166 (53)	106 (34)	23 (7.4)	1 (0.32)	2 (0.64)	13 (4.2)	311 (100)
Age*							
18 to 24 years	32 (46)	25 (36)	7 (10)	2 (2.9)	0 (0)	4 (5.7)	70 (100)
25 to 44 years	149 (59)	82 (32)	11 (4.4)	1 (0.40)	2 (0.79)	8 (3.2)	253 (100)
45 years+	148 (52)	93 (33)	27 (9.6)	0 (0)	0 (0)	14 (5.0)	282 (100)
Drinking frequency							
Daily	47 (52)	29 (32)	11 (12)	0 (0)	0 (0)	4 (4.4)	91 (100)
Weekly	176 (54)	109 (33)	21 (6.4)	3 (0.92)	1 (0.31)	16 (4.9)	326 (100)
Less than weekly	108 (57)	59 (31)	13 (6.9)	0 (0)	1 (0.53)	7 (3.7)	188 (100)
SEIFA							
1	78 (57)	42 (30)	9 (6.5)	0 (0)	1 (0.72)	8 (5.8)	138 (100)
2	69 (48)	58 (40)	12 (8.3)	1 (0.69)	1 (0.69)	3 (2.1)	144 (100)
3	92 (60)	40 (26)	14 (9.1)	0 (0)	0 (0)	8 (5.2)	154 (100)
4	92 (54)	57 (34)	10 (5.9)	2 (1.2)	0 (0)	8 (4.7)	169 (100)
Total	331 (55)	197 (33)	45 (7.4)	3 (0.50)	2 (0.33)	27 (4.5)	605 00)

[1]Other: distance did not influence the decision about where to purchase alcohol
* Chi^2 test indicated a significant difference across categories ($p<0.05$)

6.2.5 On-premise purchases

Hotel or Tavern

A total of 370 of the online survey participants had purchased alcohol from a hotel or tavern in the last 12 months (male: n=195, 53%; 18 to 24 year olds: n=48, 13%). Results of the distances participants were prepared to travel to purchase alcohol at a nightclub are shown in Table 6.10 below. Higher proportions of female participants were prepared to travel further than male participants to purchase alcohol at a hotel or tavern (more than 25%

would travel 20km or more, compared to less than 17% of male participants). Higher proportions of respondents were not influenced by distance when choosing a hotel or tavern (nearly 11% overall). This was particularly noticeable among the participants who drank less than weekly (28%) and those aged 18 to 24 years (28%). Differences across the three age groups were significant. The highest proportions of those prepared to travel 20km or more to a hotel or tavern were in the highest and lowest SEIFA categories (approximately 10% and 9% respectively).

Table 6.10**:** Distance that online survey participants were prepared to travel to purchase alcohol at a hotel or tavern, by socio-demographic factors, in Australian capital cities in 2012

Distance	Less than 5km	5km to 9km	10km to 19km	20km to 50km	More than 50km	Other[1]	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gender							
Male	101 (52)	43 (22)	22 (11)	10 (5.1)	0 (0)	19 (9.7)	195 (100)
Female	76 (43)	54 (31)	20 (11)	10 (5.7)	4 (2.3)	11 (6.3)	175 (100)
Age							
18 to 24 years	21 (44)	8 (17)	8 (17)	3 (6.3)	3 (6.3)	5 (10)	48 (100)
25 to 44 years	68 (40)	49 (29)	21 (12.4)	13 (7.7)	1 (0.59)	17 (10)	169 (100)
45 years+	88 (58)	40 (26)	13 (8.5)	4 (2.6)	0 (0)	8 (5.2)	153 (100)
Drinking frequency							
Daily	25 (48)	14 (27)	8 (15)	2 (3.9)	0 (0)	3 (5.8)	52 (100)
Weekly	91 (46)	52 (26)	23 (12)	13 (6.6)	4 (2.0)	15 (7.6)	198 (100)
Less than weekly	61 (51)	31 (26)	11 (9.2)	5 (4.2)	0 (0)	12 (10)	120 (100)
SEIFA							
1	55 (52)	23 (22)	11 (10)	8 (7.6)	1 (0.94)	8 (7.6)	106 (100)
2	40 (43)	35 (37)	6 (6.4)	4 (4.3)	0 (0)	9 (9.6)	94 (100)
3	44 (50)	21 (24)	16 (18)	1 (1.1)	2 (2.3)	4 (4.6)	88 (100)
4	38 (46)	18 (22)	9 (11)	7 (8.5)	1 (1.2)	9 (11)	82 (100)
Total	177 (48)	97 (26)	42 (11)	20 (5.4)	4 (1.1)	30 (8.1)	370 (100)

[1]Other: distance did not influence the decision about where to purchase alcohol
* Chi^2 test indicated a significant difference across categories ($p<0.05$)

Nightclub

A total of 176 of the online survey participants had purchased alcohol from a nightclub in the last 12 months (male: n=89, 51%; 18 to 24 year olds: n=39, 22%). Results of distances participants were prepared to travel to purchase alcohol at a nightclub are shown in Table 6.11 below. Differences between the distances participants were prepared to travel differed little by gender, with a few female participants being prepared to travel more than

50km to a nightclub (9.2% of females, compared to no male participants). Those in the 18 to 24 year old age group had the highest proportion of participants who were not influenced by distance to a nightclub (28%). The group of respondents who drank less than weekly contained the highest proportion of those not influenced by distance to a nightclub (nearly 28% compared to approximately 10% in the other groups). Similarly to hotels or taverns, the highest proportions of those prepared to travel 20km or more were in the highest and lowest SEIFA categories (both approximately 30% of participants in their SEIFA category).

Table 6.11: Distance that online survey participants were prepared to travel to purchase alcohol at a nightclub, by socio-demographic factors, in Australian capital cities in 2012

Distance	Less than 5km	5km to 9km	10km to 19km	20km to 50km	More than 50km	Other[1]	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gender							
Male	25 (28)	11 (12)	22 (25)	15 (17)	0 (0)	16 (18)	89 (100)
Female	22 (25)	12 (14)	19 (22)	14 (16)	8 (9.2)	12 (14)	87 (100)
Age							
18 to 24 years	4 (10)	4 (10)	8 (21)	7 (18)	5 (13)	11 (28)	39 (100)
25 to 44 years	23 (25)	15 (16)	22 (24)	15 (16)	2 (2.2)	15 (16)	92 (100)
45 years+	20 (44)	4 (8.9)	11 (24)	7 (16)	1 (2.2)	2 (4.4)	45 (100)
Drinking frequency							
Daily	6 (27)	5 (23)	7 (32)	2 (9.1)	0 (0)	2 (9.1)	22 (100)
Weekly	25 (25)	14 (14)	24 (24)	21 (21)	5 (5.0)	11 (11)	100 (100)
Less than weekly	16 (30)	4 (7.4)	10 (19)	6 (11)	3 (5.6)	15 (28)	54 (100)
SEIFA							
1	14 (30)	6 (13)	6 (13)	12 (26)	2 (4.4)	6 (13)	46 (100)
2	14 (30)	5 (11)	11 (24)	4 (8.7)	1 (2.2)	11 (24)	46 (100)
3	9 (20)	8 (18)	15 (33)	4 (8.7)	3 (6.5)	7 (15)	46 (100)
4	10 (26)	4 (11)	9 (24)	9 (24)	2 (5.3)	4 (11)	38 (100)
Total	47 (27)	23 (8.9)	41 (16)	29 (11)	8 (3.1)	28 (11)	176 (100)

[1]Other: distance did not influence the decision about where to purchase alcohol
* Chi^2 test indicated a significant difference across categories ($p<0.05$)

Restaurants

A total of 241 of the online survey participants had purchased alcohol from a restaurant in the last 12 months (male: n=117, 49%; 18 to 24 year olds: n=37, 15%). Results of the distances participants were prepared to travel to purchase alcohol at a restaurant are shown in Table 6.12 below. There was little difference in the distances that male and female respondents were prepared to travel to a restaurant to purchase alcohol. Generally, higher proportions of younger respondents were prepared to travel further than older respondents (nearly 25% of 18 to 24 year olds were prepared to travel more than 20km compared to nearly 18% of 25 to 44 year olds). Higher proportions of those who drank less than weekly were prepared to travel less than 5km or were not influenced by distance when deciding on a restaurant. As with other licence types, fewer of those in SEIFA levels one and four were prepared to travel to purchase alcohol, with more than 55% of those in SEIFA level four travelling less than 10km. However, based on data from focus group discussions of the pilot study, choice of restaurant is based less on alcohol price, and more on the availability of BYO alcohol (especially in the younger age-group) and the type, quality and price of the restaurant.

Table 6.12: Distance that online survey participants were prepared to travel to purchase alcohol at a restaurant, by socio-demographic factors, in Australian capital cities in 2012

Distance	Less than 5km	5km to 9km	10km to 19km	20km to 50km	More than 50km	Other[1]	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gender							
Male	33 (28)	25 (21)	25 (21)	18 (15)	0 (0)	16 (14)	117 (100)
Female	32 (26)	26 (21)	28 (23)	21 (17)	2 (1.6)	15 (12)	124 (100)
Age							
18 to 24 years	10 (27)	6 (16)	6 (16)	8 (22)	1 (2.7)	6 (16)	37 (100)
25 to 44 years	31 (26)	25 (21)	30 (25)	20 (17)	1 (0.83)	13 (11)	120 (100)
45 years+	24 (29)	20 (24)	17 (20)	11 (13)	0 (0)	12 (14)	84 (100)
Drinking frequency							
Daily	6 (20)	11 (37)	6 (20)	4 (13)	0 (0)	3 (10)	30 (100)
Weekly	36 (26)	30 (22)	31 (23)	26 (19)	1 (0.73)	13 (9.5)	137 (100)
Less than weekly	23 (31)	10 (14)	16 (22)	9 (12)	1 (1.4)	15 (20)	74 (100)
SEIFA							
1	15 (27)	14 (25)	6 (11)	12 (21)	1 (1.8)	8 (14)	56 (100)
2	16 (25)	12 (19)	15 (24)	11 (17)	0 (0)	9 (14)	63 (100)
3	15 (25)	10 (14)	20 (33)	8 (13)	1 (1.6)	7 (11)	61 (100)
4	19 (31)	15 (25)	12 (20)	8 (13)	0 (0)	7 (11)	61 (100)
Total	65 (27)	51 (21)	53 (22)	39 (16)	2 (0.83)	31 (13)	241 00)

[1]Other: distance did not influence the decision about where to purchase alcohol

6.2.6 The mediating effect of discounts on distance travelled to purchase alcohol

Participants were asked how much further they were preferred to travel for a price discount. The four discount levels were: 10%, 25%, 30% and 50% (based on the results of the pilot study), and the distance bands were: no further, less than 5km, 5km to 9km, 10km to 19km, 20 to 50km and more than 50km. The results are presented for the total sample. More than 80% of participants (n=543) were prepared to travel further for a price discount of 25% at a bottle shops (Table 6.13).

Table 6.13: Distance that online survey participants were prepared to travel to receive a price discount at a bottle shop in Australian capital cities in 2012

Distance travelled	10% discount	25% discount	30% discount	50% discount
No further	351 (52)	138 (20)*	117 (17)*	111 (16)*
Less than 5km further	201 (30)	237 (35)	154 (23)*	86 (13)*
5km to 9km further	86 (13)	205 (30)*	222 (33)*	154 (23)*
10km to 19km further	33(4.9)	86 (13)*	159 (23)*	227 (33)*
20km to 50km further	1 (0.15)	14 (2.1)*	25 (3.7)*	84 (12)*
More than 50km	9 (1.3)	1 (0.15)	4 (0.59)	19 (2.8)
Total	681 (100)	681 (100)	681 (100)	681 (100)

* Significantly different to 10% discount (p<0.0001)

A high proportion of participants were prepared to travel further to supermarket bottle shops and hotels or tavern (n=579; 75% and n=333; 63% respectively for a 25% discount – Tables 6.14 and 6.15).

Table 6.14: Distance that online survey participants were prepared to travel to receive a price discount at a supermarket liquor store in Australian capital cities in 2012

Distance travelled	10% discount	25% discount	30% discount	50% discount
No further	341 (56)	159 (26)*	124 (21)*	112 (19)*
Less than 5km further	173 (29)	230 (38)	152 (25)	88 (15)*
5km to 9km further	63 (10)	158 (26)*	185 (31)*	144 (24)*
10km to 19km further	21 (3.5)	53 (8.8)*	119 (20)*	189 (31)*
20km to 50km further	3 (0.50)	3 (0.50)	23 (3.8)*	51 (8.4)*
More than 50km	4 (0.66)	2 (0.33)	2 (0.33)	21 (3.5)
Total	605 (100)	605 (100)	605 (100)	605 (100)

* Significantly different to 10% discount (p<0.0001)

Table 6.15: Distance that online survey participants were prepared to travel to receive a price discount at a hotel or tavern in Australian capital cities in 2012

Distance travelled	10% discount	25% discount	30% discount	50% discount
No further	228 (62)	137 (37)*	170 (46)*	114 (31)*
Less than 5km further	80 (22)	108 (29)	81 (22)	47 (13)
5km to 9km further	37 (10)	86 (23)*	92 (25)*	81 (22)*
10km to 19km further	20 (5.4)	32 (8.7)	58 (16)*	80 (22)*
20km to 50km further	3 (0.81)	6 (1.6)	21 (5.7)	33 (8.9)*
More than 50km	2 (0.54)	1 (0.27)	1 (0.27)	15 (4.1)
Total	370 (100)	370 (100)	370 (100)	370 (100)

* Significantly different to 10% discount (p<0.0001)

A lower proportion of participants were prepared to travel further to nightclubs and restaurants for a price discount (Tables 6.16 and 6.17).

Table 6.16: Distance that online survey participants were prepared to travel to receive a price discount on alcohol at a nightclub in Australian capital cities in 2012

Distance travelled	10% discount	25% discount	30% discount	50% discount
No further	100 (57)	80 (45)	75 (43)	74 (42)
Less than 5km	31 (18)	34 (19)	32 (18)	25 (14)
5km to 9km	20 (11)	33 (19)	30 (17)	26 (15)
10km to 19km	14 (8.0)	18 (10)	24 (14)	22 (13)
20km to 50km	7 (4.0)	9 (5.1)	13 (7.4)	23 (13)
More than 50km	4 (2.3)	2 (1.1)	2 (1.1)	6 (3.4)
Total	176 (100)	176 (100)	176 (100)	176 (100)

* Significantly different to 10% discount (p<0.0001)

Table 6.17: Distance that online survey participants were prepared to travel to receive a price discount on alcohol at a restaurant in Australian capital cities in 2012

Distance travelled	10% discount	25% discount	30% discount	50% discount
No further	144 (60)	111 (46)	96 (40)*	95 (39)*
Less than 5km	55 (23)	57 (24)	52 (22)	32 (13)
5km to 9km	22 (9.1)	46 (19)	49 (20)	47 (20)
10km to 19km	14 (5.8)	20 (8.3)	29 (12)	42 (17)*
20km to 50km	5 (2.1)	6 (2.5)	14 (5.8)	19 (7.9)
More than 50km	1 (0.41)	1 (0.41)	1 (0.41)	6 (2.5)
Total	241 (100)	241 (100)	241 (100)	241 (100)

* Significantly different to 10% discount (p<0.0001)

6.3 Discussion and summary

The chapter described the process of piloting and conducting the online survey which aimed to determine distances that residents of Australian capital cities were prepared to travel to purchase alcohol.

More than 50% and 27% of participants were prepared to travel less than 5km to off-premise and on-premise outlets respectively. The vast majority of participants were not prepared to travel more than 20km to off-premise outlets and restaurants (95% and 70% respectively). Participants were prepared to travel further to visit nightclubs, taverns and hotels, with nearly 50% of participants being prepared to travel more than 20km to purchase alcohol, and higher proportions of respondents were not influenced by distance to these outlet types (over 10%).

The results on the purchasing behaviour at off-premise outlets were considered the best indicator of alcohol purchasing behaviour for the following reasons:

(a) A higher proportion of survey respondents (n=681; 82%) purchased alcohol at bottle stores than hotels (n=370; 45%) and nightclubs (n=176; 21%)

(b) Consumers visit off-premise outlets purely to buy alcohol (and not for the entertainment or food available at on-premise outlets)

(c) Sales at off-premise outlets were considerably higher than at on-premise outlets (see Chapter 6)

Consequently, distances travelled to off-premise outlets were used to choose buffer zones for the analysis in Phases three and four.

7 Results from Phases Three and Four: Collation of Alcohol Availability Data and Final Model Development

This chapter describes the results obtained in Phases three and four of this study. In 7.1, the three measures of alcohol availability (wholesale sales of alcohol to retailers, counts of alcohol outlets and trading hours) are described. Section 7.2 outlines the variables chosen to characterise the demographic and socio-economic status of populations at both the postcode- and suburb-level. Section 7.3 outlines the development of models including alcohol availability data and measures of alcohol-related injury, and the development of spatial models.

7.1 Description of alcohol availability data

Numerous past studies have used outlet density as a measure of alcohol availability (e.g. [11, 19, 262, 267]). Measures of outlet density use counts of outlets as the numerator and either land area, roadway miles or population as the denominator.

This study used the same measures of alcohol availability as the West Australian study by Liang and Chikritzhs [22]: counts of outlets and volumes of wholesale purchases (referred to hereafter as alcohol sales). Using counts of outlets facilitated the analysis of data using different administrative areas (postcodes and suburbs in this study) and varying buffers from the centroids of these administrative areas.

However, using counts of outlets as a measure of availability failed to account for the differences in the size and nature of outlets, such as a boutique wine store as compared to a liquor warehouse-style store. Using volumes of alcohol sales as an additional measure of availability provided a means of controlling, at least in part, for these differences [22]. In this study, volumes of alcohol sales were converted into pure alcohol, to allow comparison across beverage types (4.6.2).

7.1.1 Counts of alcohol outlets

The Drug and Alcohol Office of Western Australia (DAO) provided counts of outlets for each financial year from 1 July 2002 to 30 June 2010. Most outlets had previously been geocoded by a geographer at the National Drug Research Institute (NDRI). Additional outlets were geocoded and checked by a member of the Alcohol Policy group at the NDRI. Outlets were assigned to relevant suburbs, postcodes and buffer zones based on the geocoded data.

Types of outlets were identified by the first three digits of each licence number. There were six licence categories used – five on-premise types and one off-premise type:

(a) On-premise outlets: hotels or taverns, clubs (e.g. bowling clubs), restaurants or cafés, nightclubs, and other outlets[59]
(b) Off-premise outlets, that is, liquor stores – this licence type included supermarket liquor stores

Table 7.1 below displays the descriptive statistics of each outlet type at postcode-level. The maximum number of on-premise outlets per postcode was 183: in postcode 6000 (which is the City of Perth) in the financial year 2008/09 (data not shown). The count of off-premise outlets per postcode was much lower, with a maximum of 13 outlets in postcode 6056 (which included Midland, Middle Swan and Helena Valley) between 2007/08 and 2009/10 and a mean of 2.6 outlets per postcode.

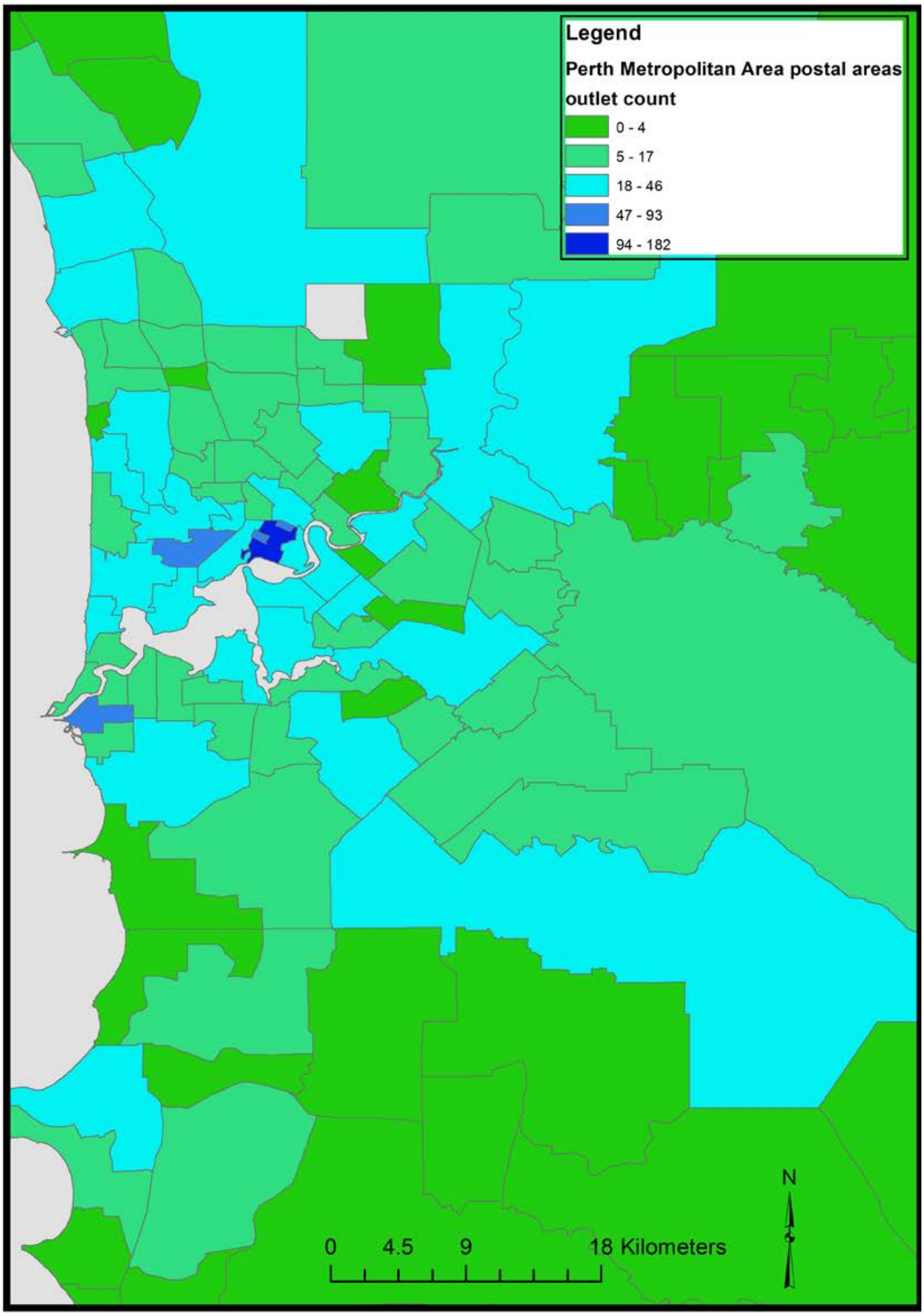
Table 7.1: Descriptive statistics for counts of alcohol outlets in Perth Metropolitan area, by postcode, 2002/03 to 2009/10

Variable	2009/10	2002/03 to 2009/10			
	Total (%)	Mean	Std. Dev.	Min	Max
Count of clubs	177 (10)	1.6	1.9	0	11
Count of hotels and taverns	333 (19)	2.6	4.2	0	54
Count of nightclubs	29 (1.7)	0.28	1.3	0	12
Count of restaurants	550 (32)	4.6	8.3	0	61
Count of other licences	325 (18)	2.6	5.6	0	59
Count of all on-premise outlets	1,414 (82)	12	19	0	183
Count of off-premise outlets (liquor stores)	318 (18)	2.6	2.1	0	13

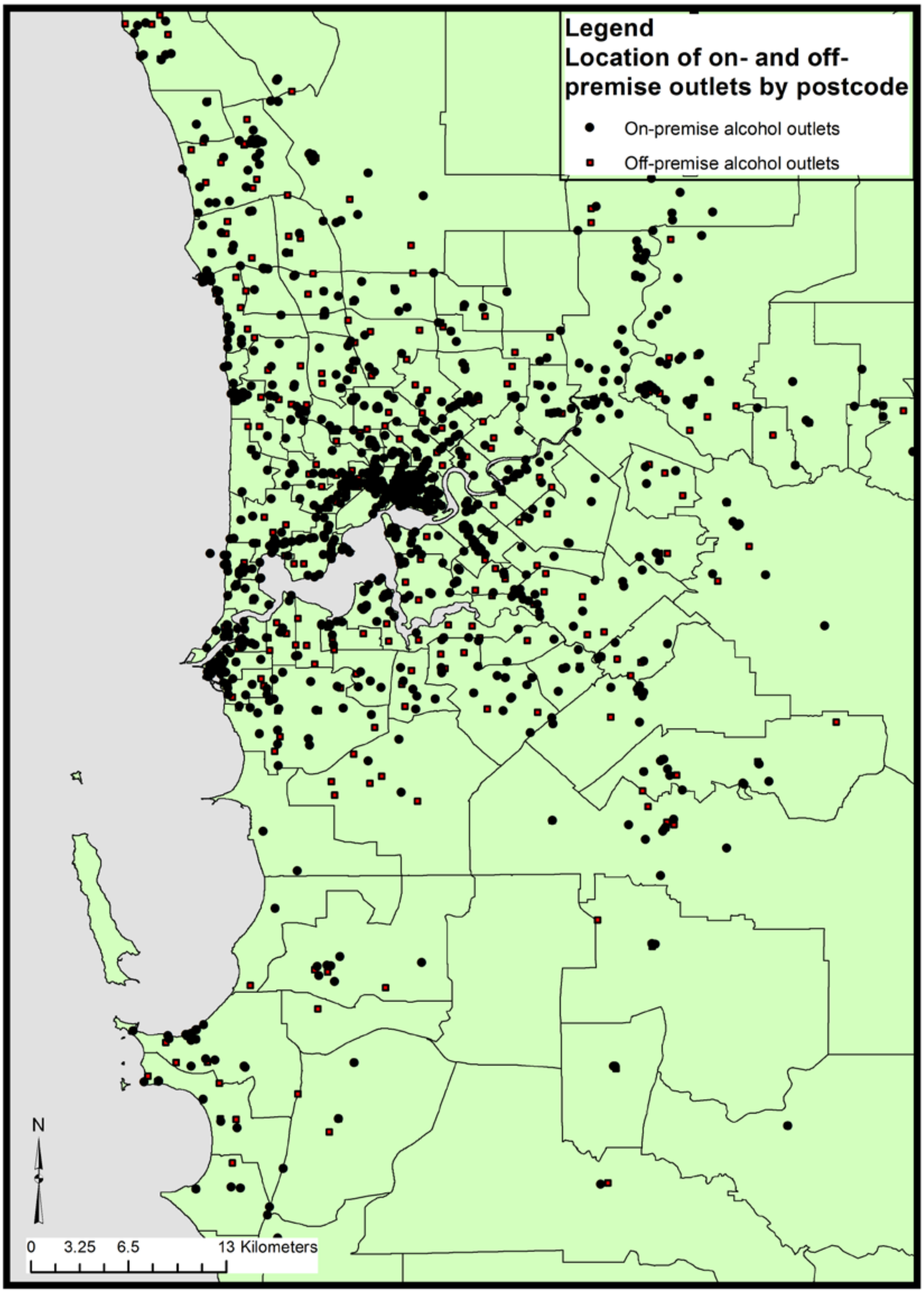
Map 7.1 shows the total count of outlets per postcode in Perth Metropolitan Area in 2009/10. The map demonstrates that the highest number of outlets per postcode were near the CBD (Perth City, Northbridge and Subiaco) and Fremantle. Map 7.2 demonstrates the location of on- and off-premise outlets at postcode-level in Perth Metropolitan Area for 2009/10. The map shows the clustering of on-premise outlets throughout the metropolitan area. This is more noticeable near the CBD and along the coast. Off-premise outlets are more dispersed.

[59] 'Other' licence types include special facility licences, wine distributors and canteens

Map 7.1: Geographic distribution of total counts of licensed outlets per postcode in Perth Metropolitan Area in 2009/10



Map 7.2: Locations of on- and off premise outlets by postcode in Perth Metropolitan Areas in 2009/10



7.1.2 Alcohol sales data

As described in Chapter three, sales data were provided in five categories: regular beer, low alcohol beer, regular wine, low alcohol wine and spirits. These were converted into pure alcohol (in litres). Total spirits were disaggregated into straight spirits and ready to drink (RTD) spirits, as described in 4.6.2.

Volumes of each beverage type were available for each of the six licence types described in 7.1.1. These were aggregated to total sales at on-premise outlets and total sales at off-premise outlets for the final models, because of the small sales volumes of individual beverage types at outlets further from the CBD.

Table 7.2 below describes pure alcohol sales at postcode-level. The highest mean sales at on-premise outlets were for regular strength beer (that is, beer with a pure alcohol content of greater than 3.5% of volume) which accounted for more than 40% of mean on-premise sales. Regular strength wine had the second highest mean sales. This relationship was reversed at off-premise outlets, with much higher sales of regular strength wine.

Table 7.2: Descriptive statistics of pure alcohol volumes per financial year in Perth Metropolitan Area, at postcode-level, 2002/03 to 2009/10

On-premise sales	Mean	Std. Dev.	Min	Max
Regular strength beer	20,659	25,431	0	297,582
Low strength beer	4,186	5,045	0	39,919
Regular strength wine	12,322	19,216	0	238,379
Low strength wine	44	143	0	1,404
Straight spirits	5,867	7,104	0	68,597
Ready to Drink spirits	5,011	6,187	0	64,607
Total on-premise sales	48,089	58,143	0	709,098
Off-premise sales				
Regular strength beer	22,464	32,088	0	486,724
Low strength beer	5,512	7,375	0	73,320
Regular strength wine	28,049	36,106	0	406,387
Low strength wine	44	138	0	1,798
Straight spirits	5,916	8,293	0	94,511
Ready to Drink spirits	5,132	7,397	0	89,013
Total off-premise sales	67,116	80,079	0	618,060

As indicated in 7.1, wholesale sales of individual beverage types to retail outlets (alcohol sales) were converted to pure alcohol sales to standardise beverages with different alcohol strengths and enable calculation of total pure alcohol sales. Sales were categorised as being from on-or off-premise, rather than by individual licence type. There were three reasons for this: i) there were relatively small numbers of each licence type per postcode (especially in the outer metropolitan area), ii) there were small volumes of sales at certain on-premise outlet types (such as clubs), and iii) using six licence types would have reduced the parsimony of the multivariate analysis. These factors would have led to models with much lower statistical power than if licence types were aggregated to on- and off-premise sales.

As discussed in Chapter three, previous studies examining the relationship between harms and alcohol sales are less common than those exploring the relationship between harms and outlet density. Studies have examined both total volumes (for example [29]) and pure alcohol sales (for example [23]. Measures of sales used have included pure alcohol in grams [364] and pure alcohol in litres per population over 15 years old [267]. Several studies have used average sales per outlet (that is, pure alcohol sales in litres divided by the count of outlets in the area examined) [22, 23, 365, 372]. The advantage of this measure is that collinearity between counts of outlets and pure alcohol sales per outlet is much lower than between outlet counts and pure alcohol sales. Using the data from this study, this was demonstrated in Table 7.6. As a result of these findings, 'pure alcohol sales per outlet' was chosen as the measure of sales in this study.

7.1.3 Trading hours data

As described in Chapter four, data was collated on outlets which held extended trading permits (ETPs) allowing extended trading hours. Those in category one were permitted extended hours over some or all weekdays as well as weekends (etp1). Those in category two were permitted extended trading hours on Friday, Saturday or Sunday, or a combination of these three weekend nights (etp2). Those in category three were not in possession of an ETP allowing extended trading hours (etp3). Table 7.3 shows the descriptive statistics for extended trading hours at postcode-level.

Table 7.3: Descriptive statistics for outlets granted extended trading hours per financial year in Perth Metropolitan Area, by postcode, from 2002/03 to 2009/10

	2009/10	2002/03 to 2009/10			
Trading hours	Total (%)	Mean	Std. Dev.	Min	Max
Friday to Sunday extended trading hours	44 (2.5)	0.51	1.4	0	13
Weekday and weekend extended trading hours	23 (1.3)	0.09	0.48	0	5
No extended trading hours	1,678 (96)	14	18	1	181

7.2 Choice of ABS demographic and socio-economic variables

A range of postcode- and suburb-level socio-economic and demographic data was obtained from the Australian Bureau of Statistics (ABS) census web-site. The source of each variable for each of three censuses (2001, 2006 and 2011) and processing this data was described in detail in 4.6.2. The choice of variables was consistent with previous outlet density studies and based on two previous analyses by the NDRI Alcohol Policy group: *"Predicting alcohol-related harms from licensed outlet density: a feasibility study"* [29]; and *"Revealing the link between licensed outlets and violence: counting venues versus measuring alcohol availability"* [22]. The latter study was particularly applicable as it used similar measures of alcohol availability to this project.

The measure of socio-economic status was the Socio-Economic Indexes for Areas (SEIFA): Index of Advantage/Disadvantage. This index combines measures of advantage with those of disadvantage (including aspects such as education level, employment status, income, occupation, characteristics of places of residence (rental, ownership), relationship status and internet access [452]). The SEIFA Index of Advantage/Disadvantage for each area (suburb- and postcode-level) was divided into quartiles, creating a categorical variable with four values. SEIFA category one included postcodes with the lowest socio-economic status, while SEIFA category four included postcodes with the highest socio-economic status.

Demographic factors were measured using data on age, gender and Indigenous status from censuses in 2001, 2006 and 2011. Data on employment status were also obtained from these censuses.

Table 7.4 describes the socio-economic and demographic variables used and the method of calculating them.

Table 7.4: Socio-economic and demographic variables from the ABS with descriptive statistics at postcode-level, Perth Metropolitan Area, from 2002/03 to 2009/10

Variable	Description	Mean	Std. Dev.	Min	Max
Estimated resident population 15+ years	Total population over 15	10,443	8,879	1	42,040
SEIFA index of advantage/disadvantage	Divided into quartiles	1,037	63	889	1,207
Mean age	Sum of all ages/total population	36	2.3	31	61
Indigenous rate	Indigenous/Non-Indigenous*100	2.7	12	0	145
Proportion young males	No. males aged 15-24/Total population*100	7.3	1.8	0	15
Ratio of males to females	No. males/No. females*100	101	35	0	380
Unemployment rate	Unemployed/unemployed*100	5.2	3.5	0	56

Table 7.5 shows the correlations[60] between each socio-economic and demographic variable used, both at postcode- and suburb-level. Correlations between the variables were small to medium, with the highest being between unemployment rate and SEIFA (r = -0.53 at suburb-level, and r = -0.40 at postcode-level). Unemployment rate and SEIFA quartile had a slightly lower correlation. Both were retained as the individual variables were considered important and the correlation not high enough to preclude the inclusion of both.

Table 7.5: Associations between ABS socio-economic and demographic variables (Pearson's r), by postcode, in Perth Metropolitan Area, from 2002/03 to 2009/10

	ERP 15+	SEIFA	SEIFA quartile	Mean age	Indigenous %	Young males%	Male/ female%	Unemploy-ment%
ERP 15+	1							
SEIFA	-0.03	1						
SEIFA quartile	-0.01	0.94	1					
Mean age	0.01	0.38	0.37	1				
Indigenous%	0.05	-0.70	-0.68	-0.22	1			
Young males%	0.21	0.08	0.09	0.02	0.09	1		
Male/female%	-0.27	-0.19	-0.17	-0.15	0.36	0.16	1	
Unemployment%	0.04	-0.40	-0.34	-0.03	0.35	0.12	0.03	1

[60] Pearson's Coefficient of Correlation ('r') measures the relationship between x and y (variables). The range of r is from -1 (perfect negative correlation) to 1 (perfect positive correlation). If r = 0, there is no linear relationship between two variables. Values closer to -1 and 1 indicate a strong relationship or a strong level of correlation between two variables [453].

7.3 Statistical model development

7.3.1 Choice of measures of alcohol sales

As discussed in 7.1.2, various measures of volumes of sales have been used in previous alcohol availability studies. It was anticipated that a high level of collinearity would exist between pure alcohol sales and outlet counts, and much lower collinearity between average sales (sales per outlet) and outlet counts. Table 7.6 shows the correlations between these two measures of sales, and outlet count. Counts of on-premise outlets and on-premise sales, and counts of off-premise outlets and off-premise sales were highly correlated, compared to counts of outlets and sales per outlet. As the number of outlets go up, the sales would be expected to rise in line with this - although the degree of correlation would vary, depending on the relative size of the outlets. However "sales per outlet" measures the mean sales per outlet and so is less correlated with counts of outlets. This suggested that on- and off-premise sales per outlet were a better choice to measure sales.

Table 7.6: Associations between measures of alcohol sales and outlet counts (Pearson's r), by postcode, in Perth Metropolitan Area, from 2002/03 to 2009/10

	Count of on-premise outlets	Count of off-premise outlets	On-premise sales#	Off-premise sales#	On-premise sales#/ outlet	Off-premise sales#/ outlet
Count of on-premise outlets	1					
Count of off-premise outlets	0.31	1				
On-premise sales#	0.69	0.36	1			
Off-premise sales#	0.08	0.77	0.25	1		
On-premise sales#/outlet	-0.19	0.02	0.36	0.10	1	
Off-premise sales#/outlet	-0.15	0.12	0.02	0.60	0.13	1

Sales in 10,000l

7.3.2 Association between measures of alcohol-related injury and alcohol availability

As previously discussed, several surrogate measures of alcohol-related injury were explored. Two surrogate measures of alcohol-related injury used in the final models: Night2 injuries (those injuries occurring between midnight and 4:59am in the morning); and modified Weekend Night2 injuries (the modified Weekend period was defined in Chapter five as the period from Friday 6pm to Monday 6:59am; all Night2 injuries occurring during this time were included in this surrogate measure).

The correlations between the two measures of alcohol-related injury, counts of outlets and sales volumes per outlet are presented in Table 7.7. The strongest correlations were between counts of off-premise outlets and both Night2 and Weekend Night2 injuries.

Table 7.7: Associations between alcohol-related injury indicators and measures of alcohol availability (Pearson's r), in Perth Metropolitan Area, from 2002/03 to 2009/10

Injury category	Night2	Weekend Night2
Count of on-premise outlets	0.08	0.06
Count of off-premise outlets	0.63	0.60
On-premise sales#/outlet	0.22	0.22
Off-premise sales#/outlet	0.28	0.29

#Sales in 10,000 litres

7.3.3 Panel models: time series and geographic units:

Negative binomial regression with random effects were undertaken. The time variable was financial years (that is, from 1 July of one year to 30 June the following year). As discussed in 4.4.1, ED data was available from 1 July 2002 to 30 June 2010. However, in the first two financial years (2002/03 and 2003/4), Joondalup Health Campus (JHC) data was missing because this hospital only began using the Emergency Department Information System (EDIS) in late July 2004. As approximately 12% of ED presentations at Perth public hospitals occurred at JHC, this resulted in lower ED presentations reported in the EDIS records for the financial years 2002/03 and 2003/04. This occurred in the main catchment area around JCH, specifically in the following postcodes: 6023, 6024, 6026, 6027, 6028 and 6065.

It was decided to use the longer time series (2002/03 to 2009/10) for the final models as these models provided greater statistical power to detect differences due to the additional number of units (eight years multiplied by the number of postcodes, compared to six years multiplied by the number of postcodes). A comparison between the two times series is presented using the final and most complete models in 7.2.9 to assess the differences between the models using different time series. Other models for the 2004/05 to 2009/10 time series are shown in the Appendix (10.10).

Two sets of models were developed. The first set used ‘postcode’ as the panel variable, while the second set used ‘suburb’. Suburb models had the advantage of more power: as the Perth Metropolitan Area has more suburbs than postcodes, these models contained more panels. However, data was missing or zero in several suburbs, and suburb definitions varied across the different data sets. The postcode-level data was more accurate and so these models were displayed in rest of this chapter. As a result, the suburb models represented a sensitivity analysis. The postcode and suburb final models are compared in 7.2.9. All other suburb models can be found in the Appendix (10.10).

7.3.4 Simple negative binomial regression models with random effects for the years 2002/03 to 2009/10

Simple regression models were constructed in turn with each alcohol availability variable as the predictor variable and each outcome variable (Night2 injuries and Night2 Weekend injuries) at postcode-level. Table 7.8 demonstrates the relationship between counts of all alcohol outlets with Night2 and Weekend Night2 injuries. Across both measures of injury, the associations were positive and significant. An increase of one outlet was associated with a 1.6% increase in risk of Weekend Night2 injury.

Table 7.8: Panel model results for counts of all outlets in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of all outlets	1.012*	1.008	1.015	1.016*	1.011	1.020

* $p<0.05$

Table 7.9 demonstrates the association between counts of on-premise outlets, with Night2 and Weekend Night2 injuries. The count of on-premise outlets was positively and significantly associated with both categories of alcohol-related injury at postcode-level. An increase of one on-premise outlet was associated with a 1.5% increase in risk of Weekend Night2 injury.

Table 7.9: Panel model results for counts of on-premise outlet in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.011*	1.008	1.015	1.015*	1.011	1.020

* $p<0.05$

Table 7.10 demonstrates the association between counts of off-premise outlets, with Night2 and Weekend Night2 injuries. Both Night2 and Weekend Night2 injuries were positively and significantly associated with counts of off-premise outlets. An increase of one off-premise outlet was associated with a 15% increase in risk of Weekend Night2 injury.

Table 7.10: Panel model results for counts of off-premise outlet in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of off-premise outlets	1.120*	1.081	1.161	1.150*	1.107	1.195

* $p<0.05$

Table 7.11 demonstrates the association between all alcohol sales per 10,000 litres divided by total count of outlets, with Night2 and Weekend Night2 injuries. The unadjusted association between all sales per outlet and Night2 injuries was strong and significant. An increase of 10,000l of sales per outlet was associated with a 7% increase in Night2 injuries.

Table 7.11: Panel model results for total sales per outlet in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
All sales#/outlet	1.070*	1.025	1.117	1.068*	1.018	1.120

Sales in 10,000 litres * $p<0.05$

Table 7.12 demonstrates the association between all on-premise alcohol sales per 10,000 litres, divided by count of on-premise outlets, with Night2 and Weekend Night2 injuries at postcode-level. The associations were not significant.

Table 7.12: Panel model results for sales per on-premise outlet in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet	1.029	0.975	1.086	1.018	0.959	1.080

#Sales in 10,000 litres * p<0.05

Table 7.13 demonstrates the association between all off-premise alcohol sales per 10,000 litres, divided by count of off-premise outlets, with Night2 and Weekend Night2 injuries at postcode-level. The associations between Night2 and Night2 Weekend off-premise sales per outlet were positive and significant. An increase of 10,000l of sales per off-premise outlet was associated with a 2.4% increase in Night2 and Weekend Night2 injuries.

Table 7.13 Panel model results for sales per off-premise outlet in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Off-premise sales#/outlet	1.024*	1.008	1.041	1.024*	1.007	1.043

Sales in 10,000 litres * p<0.05

7.3.5 Base models including counts of outlets and their sales

Models were then developed which included both measures of alcohol availability (counts of outlets and sales per outlet). Both outlet counts and sales per outlet were disaggregated into on- and off-premise types, as it was hypothesised that the mechanisms differ between alcohol-related harm and: on-premise outlets (the effects on alcohol-related harm tended to be more related to amenity), and off-premise outlets (more proximity effects) [218]. Because of the small number of outlets per licence type, all on-premise licence types were aggregated into one category. The off-premise category included one licence type: liquor stores (bottle shops).

The models were developed separately for each outcome variable (Night2 and Weekend Night2 injuries), and executed firstly with postcode and then with suburb as the panel variable. Postcode-level models for the time period from 2002/03 to 2009/10 are shown below. Postcode models with data from 2004/05 and suburb models are presented in the Appendix (10.10).

The initial model (Table 7.14) included counts and sales of on- and off-premise sales and outlet counts, unadjusted for demographic and socio-economic variables. The models in Table 7.15 included an exposure variable: estimated resident population of those 15 years and older (ERP15+). Table 7.16 displays the models which included postcode-level socio-economic status (represented by the SEIFA Index of Advantage/Disadvantage quartile) as a predictor variable. Finally, the models which adjusted for all ABS demographic and socio-economic variables (as described in Table 7.4) are presented in Table 7.17. This model included 718 observations.

The unadjusted models revealed significant positive associations between alcohol-related injuries and counts of on- and off-premise outlets and sales per off-premise outlet (Table 7.14). However, counts of off-premise outlets were not significantly associated with injury once estimated resident population was controlled for (Table 7.15) or when all socio-economic and demographic variables were adjusted for (Table 7.17).

Table 7.14: Panel model results for sales and counts of on- and off-premise outlets in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.008*	1.004	1.012	1.010*	1.005	1.015
Count of off-premise outlets	1.081*	1.039	1.125	1.105*	1.059	1.153
On-premise sales#/outlet	1.042	0.988	1.100	1.036	0.977	1.099
Off-premise sales#/outlet	1.027*	1.011	1.044	1.028*	1.009	1.046

#Sales in 10,000 litres * p<0.05

Table 7.15: Panel model results for sales and counts of on- and off-premise outlets, adjusting for population over 15 years, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.005	1.010	1.007*	1.004	1.010
Count of off-premise outlets	0.976	0.950	1.003	0.991	0.965	1.018
On-premise sales#/outlet	1.028	0.983	1.076	1.023	0.974	1.073
Off-premise sales#/outlet	1.018*	1.002	1.034	1.019*	1.003	1.036
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ERP 15+: Estimated Resident Population 15 years and older

Table 7.16: Panel model results for sales and counts of on- and off-premise outlets, adjusting for population over 15 years and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.005	1.010	1.007*	1.005	1.010
Count of off-premise outlets	0.974*	0.946	0.999	0.987	0.962	1.012
On-premise sales#/outlet	1.028	0.982	1.078	1.024	0.975	1.075
Off-premise sales#/outlet	1.020*	1.004	1.036	1.022*	1.005	1.038
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.882*	0.808	0.977	0.916	0.832	1.012
SEIFA quartile 3	0.791*	0.705	0.919	0.804*	0.712	0.920
SEIFA quartile 4	0.909	0.785	1.143	0.879	0.748	1.066
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

As shown in Table 7.17, an additional on-premise outlet per postcode was associated with a 1% increase in Night2 and Weekend Night2 injuries per year and an increase of 10,000l in off-premise sales per outlet at postcode-level was associated with an increase of 1.9% in Weekend Night2 injuries. An additional one off-premise outlet was associated with a 5.2% decrease in Night2 injuries.

The following ABS variables were also significant predictors of Night2 injuries between 2002/03 and 2009/10 (see Table 7.17): SEIFA level four (the highest level) with a 34% higher risk of Night2 injury compared to the lowest SEIFA level, and higher percentage of Indigenous residents (IRR=1.281 and 1.246 for the models using Night2 and Weekend Night2 injuries respectively). Higher proportions of males and young males per postcode were negatively associated with alcohol-related injury.

Table 7.17: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010*	1.006	1.012	1.010*	1.006	1.013
Count of off-premise outlets	0.948*	0.924	0.977	0.962*	0.935	0.990
On-premise sales#/outlet	1.029	0.986	1.075	1.026	0.979	1.075
Off-premise sales#/outlet	1.018*	1.004	1.033	1.019*	1.004	1.035
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.992	0.900	1.084	1.023	0.922	1.123
SEIFA quartile 3	1.054	0.915	1.202	1.049	0.904	1.203
SEIFA quartile 4	1.336*	1.116	1.600	1.285*	1.062	1.549
Unemployment%	0.993	0.983	1.003	0.975	0.964	0.987
Indigenous%	1.281*	1.196	1.344	1.246*	1.172	1.325
Young males%	0.966*	0.942	0.985	0.962*	0.939	0.985
Male/female%	0.986*	0.981	0.995	0.989*	0.983	0.996
Mean age	0.983*	0.973	0.993	0.992	0.981	1.003
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.6 Base models with buffer zones from geographic centroid

The adjusted model (Table 7.17) was performed using the following alternative alcohol availability variables: counts of outlets and sales per outlets in buffers 1km (Table 7.18 – 415 observations), 2km (Table 7.19 – 588 observations) and 5km (Table 7.20 – 775 observations) from the geographic centroid of the postcodes.

As indicated in Table 7.18, associations between sales and counts of outlets within 1km of the geographic centroid of the postcode and alcohol-related injury were not significantly associated with both measures of alcohol-related injury

The adjusted relationship between alcohol availability and injury by buffer from centroid at postcode-level appeared complex and merited further investigation, and is discussed further in 7.2.7 and 8.2.5.

All postcode-level models using buffer zones demonstrate that postcodes with higher percentages of Indigenous residents and in highest level of SEIFA (SEIFA quartile 4) were both associated with increased risk of alcohol-related injury.

Table 7.18: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.999	1.008	1.004	1.000	1.008
Count of off-premise outlets	0.930	0.853	1.014	0.973	0.904	1.048
On-premise sales#/outlet	1.006	0.987	1.025	0.993	0.971	1.015
Off-premise sales#/outlet	1.008	0.996	1.020	1.004	0.991	1.018
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.037	0.938	1.147	1.042	0.948	1.145
SEIFA quartile 3	0.961	0.786	1.176	0.969	0.812	1.155
SEIFA quartile 4	1.202	0.961	1.504	1.162	0.954	1.415
Unemployment%	0.969*	0.961	0.977	0.984*	0.975	0.993
Indigenous%	1.244*	1.124	1.378	1.185*	1.089	1.291
Young males%	0.956*	0.928	0.986	0.936*	0.911	0.961
Male/female%	0.988	0.976	1.000	1.008	0.998	1.018
Mean age	0.986*	0.975	0.997	0.986*	0.975	0.998
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Models comprising outlets and sales within a 2km buffer from the postcode centroid (Table 7.19) showed a significant and strongly positive association between injury and on-premise sales per outlet, with an increase of 10,000l in on-premise sales per outlet associated with a 4.6 % increase in Weekend Night2 injury. An increase of one on-premise outlet was associated with a 0.8% increase in Weekend Night2 injuries.

Table 7.19: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.005*	1.000	1.010	1.008*	1.002	1.013
Count of off-premise outlets	1.013	0.975	1.053	0.985	0.944	1.028
On-premise sales#/outlet	1.039*	1.009	1.071	1.046*	1.013	1.081
Off-premise sales#/outlet	1.008	0.995	1.021	1.004	0.990	1.019
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.061	0.952	1.183	1.086	0.968	1.219
SEIFA quartile 3	1.107	0.920	1.333	1.120	0.920	1.364
SEIFA quartile 4	1.509*	1.211	1.881	1.516*	1.198	1.919
Unemployment%	0.955*	0.947	0.963	0.948*	0.939	0.956
Indigenous%	1.478*	1.340	1.631	1.487*	1.334	1.657
Young males%	1.017	0.986	1.049	1.015	0.981	1.050
Male/female%	0.966*	0.954	0.978	0.962*	0.949	0.976
Mean age	0.999	0.988	1.011	0.997	0.984	1.010
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Interestingly, when examining availability within a 5km buffer from the postcode centroid (Table 7.20), a significant and strong positive association was found between injury and both counts and sales at off-premise outlets. An increase of 10,000l in off-premise sales per outlet was associated with a 3.8% increase in Night2 injuries, and an increase of one off-premise outlet was associated with a 2.8% increase in Night2 injuries.

Table 7.20: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.998	1.000	0.999	0.998	1.000
Count of off-premise outlets	1.028*	1.013	1.042	1.020*	1.004	1.036
On-premise sales#/outlet	1.054	0.945	1.175	1.120	0.997	1.257
Off-premise sales#/outlet	1.038*	1.020	1.058	1.036*	1.015	1.057
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.953	0.852	1.066	0.984	0.874	1.107
SEIFA quartile 3	0.838*	0.712	0.986	0.855	0.718	1.018
SEIFA quartile 4	1.134	0.935	1.376	1.170	0.949	1.444
Unemployment%	0.960*	0.951	0.968	0.949*	0.940	0.958
Indigenous%	0.988	0.973	1.004	0.982	0.965	1.000
Young males%	1.025	0.997	1.054	1.029	0.998	1.060
Male/female%	0.973*	0.964	0.982	0.972*	0.961	0.982
Mean age	1.011	0.999	1.023	1.009	0.996	1.023
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.7 Regression models including zones from the CBD

It was hypothesised that the relationship between alcohol availability and alcohol-related injury might vary because of differences in the road network and the distances and patterns of travel across the Perth Metropolitan Area. For example, those living in a postcode near the Central Business District (CBD), such as 6008 (Subiaco) or 6101 (East Victoria Park), would only need to travel short distances to reach the many on-premise outlets (restaurants and nightclubs) located in or near these postcodes. However, travel times are longer within these inner postcodes compared to travelling the same distance in outer postcodes because of increased congestion, and a road structure which requires more controlled intersections [435].

Using a framework suggested by Luk et al., Perth was divided into: the CBD, inner postcodes (outside the CBD but within 7km of the CBD), middle postcodes (7km to 15km from the CBD), and outer postcodes (more than 15km from the CBD) [435]. These four area categories were based on the distance between a pair of signals (that is, controlled intersections), also known as a road link. Within the CBD, the link length was approximately 300m. The link lengths for the inner, middle and outer postcodes and suburbs were 300m to 1,000m, 1,000m to 1.5km and more than 1.5km respectively. This framework provided a method of controlling for any spatial heterogeneity across the region (see 4.7.1).

In the absence of an objective definition of CBD for Perth, two potential definitions were explored: firstly defining the Perth CBD as Perth City (postcode 6000), and secondly basing the definition on a map of the CBD published by Landgate [399], which consisted of Perth City (6000), Northbridge (6003), East Perth (6004) and West Perth (6005). Both of these definitions were used in model development. The definition using only the postcode 6000 was referred to as 'CBD' while the definition including postcodes 6000, 6003, 6004 and 6005 was named 'big CBD'. The models using the big CBD were generally poor, and several models did not converge (see Appendix 10.10). As a result, only statistical models using 'CBD' were reported in this chapter.

The CBD consisted of eight sets of postcode data (one postcode, 6000, over eight financial years). In the final dataset, the inner postcodes consisted of 160, the middle postcodes of 279 and the outer postcodes of 489 postcode units over the eight year period.

Model stratifying by zone from the CBD

The four tables below demonstrated the models stratified by distance from the CBD for all sales and outlet counts (Tables 7.21), and for outlets within 1km (Tables 7.22), within 2km (Tables 7.23) and within 5km (Tables 7.24) of the geographic centroid of the postcode. The suburb-level models and models for the shorter time series are reported in 10.10.

The models using total counts of outlets and sales per outlets at postcode-level (Table 7.21 to 7.23) showed significant positive associations between counts of on-premise outlets and alcohol-related injury outcome variables, and significant negative associations between counts of off-premise outlets and measures of alcohol-related injury. In the zone including postcodes between the CBD and 7km from the CBD (Table 7.21 - 157 observations), a further on-premise outlet was significantly associated with a 0.9% increase in Weekend Night2 injuries.

Table 7.21: Panel model results for sales and counts of on- and off-premise outlets, from the CBD to 7km from CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

CBD to 7km	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.006*	1.001	1.012	1.009*	1.003	1.014
Count of off-premise outlets	0.926*	0.879	0.976	0.939*	0.887	0.994
On-premise sales#/outlet	1.008	0.871	1.167	0.946	0.788	1.135
Off-premise sales#/outlet	0.983	0.955	1.012	0.967	0.933	1.002
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.882	0.619	1.256	0.887	0.638	1.234
SEIFA quartile 3	0.947	0.651	1.378	0.951	0.662	1.368
SEIFA quartile 4	0.988	0.656	1.489	0.921	0.605	1.402
Unemployment%	0.997	0.980	1.014	0.990	0.969	1.012
Indigenous%	1.151*	1.006	1.316	1.135	0.993	1.297
Young males%	1.040	0.979	1.104	1.009	0.951	1.070
Male/female%	1.014*	1.003	1.025	1.014*	1.003	1.024
Mean age	1.053	0.941	1.177	1.128	0.990	1.286
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

In the zone of postcodes between 7km to 15km from the CBD (Table 7.22 - 252 observations), off-premises sales per outlet were significantly associated with alcohol-related injury: a 10,000l increase in off-premises sales per outlet was associated with a 2.4% increase in Night2 and Weekend Night2 injuries.

Table 7.22: Panel model results for sales and counts of on- and off-premise outlets, from 7km to15km from CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

7km to 15km from CBD	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.996	1.011	1.005	0.997	1.013
Count of off-premise outlets	1.004	0.970	1.039	0.995	0.963	1.029
On-premise sales#/outlet	0.988	0.945	1.032	0.979	0.930	1.030
Off-premise sales#/outlet	1.024*	1.004	1.044	1.024*	1.001	1.048
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.090	0.954	1.244	1.073	0.923	1.247
SEIFA quartile 3	0.940	0.739	1.195	0.964	0.751	1.237
SEIFA quartile 4	0.976	0.755	1.262	0.984	0.756	1.282
Unemployment%	0.995	0.986	1.003	0.990	0.980	1.000
Indigenous%	1.128*	1.037	1.226	1.121*	1.030	1.221
Young males%	0.943*	0.909	0.978	0.940*	0.903	0.978
Male/female%	0.991	0.975	1.007	0.997	0.980	1.014
Mean age	0.988*	0.977	0.999	0.987	0.974	1.000
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

In the zone encompassing postcodes 15km or more from the CBD (Table 7.23 - 301 observations), both the count and sales of on-premise outlets were significantly and positively associated with Weekend Night2 injury (count of on-premise outlet: IRR 1.021; on-premise sales per outlet: IRR 1.255). Counts of off-premise outlets were significantly associated with a 10.7% decrease in Night2 injury. In addition, there was a strongly positive association between the postcodes within the highest SEIFA level, and alcohol-related injury.

The positive association between postcodes with high proportions of residents of Indigenous origin and alcohol-related injury was evident across all zones from the CBD.

Table 7.23: Panel model results for sales and counts of on- and off-premise outlets, beyond 15km from CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

15km+ from CBD	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.021*	1.013	1.030	1.021*	1.012	1.029
Count of off-premise outlets	0.893*	0.853	0.936	0.905*	0.864	0.949
On-premise sales#/outlet	1.205*	1.081	1.342	1.255*	1.124	1.402
Off-premise sales#/outlet	1.017	0.992	1.042	1.021	0.997	1.046
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.936	0.818	1.073	0.999	0.869	1.148
SEIFA quartile 3	0.981	0.806	1.193	1.035	0.848	1.263
SEIFA quartile 4	1.421*	1.078	1.874	1.448*	1.095	1.914
Unemployment%	0.963*	0.944	0.982	0.954*	0.934	0.975
Indigenous%	1.516*	1.370	1.676	1.500*	1.346	1.673
Young males%	0.965*	0.932	0.999	0.961*	0.928	0.996
Male/female%	0.966*	0.954	0.977	0.966*	0.954	0.978
Mean age	0.991	0.966	1.016	0.994	0.969	1.020
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Models for outlet counts and sales within 1km of the geographic centroid of the geographic area are displayed in Tables 7.24 to 7.26. At postcode-level, between the CBD and 7km from the CBD (Table 7.24 - 149 observations), associations between alcohol-related injury and count of on-premise outlets were positive and significant (Weekend Night2 IRR 1.009). However, an increase in off-premise outlets was negatively associated with alcohol-related injuries (an increase of 10,000l in off-premise sales per outlet was associated with a 10% decrease in Weekend Night2 injuries).

Table 7.24: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes from the CBD to 7km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.003	1.011	1.009*	1.004	1.013
Count of off-premise outlets	0.901*	0.827	0.981	0.896*	0.818	0.983
On-premise sales#/outlet	1.012	0.941	1.087	1.004	0.921	1.094
Off-premise sales#/outlet	0.979	0.953	1.006	0.988	0.958	1.020
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.354	0.853	2.150	1.288	0.793	2.091
SEIFA quartile 3	1.597	0.952	2.679	1.489	0.845	2.624
SEIFA quartile 4	1.714	0.981	2.996	1.566	0.836	2.932
Unemployment%	1.000	0.984	1.017	0.991	0.970	1.012
Indigenous%	1.360*	1.150	1.607	1.302*	1.073	1.581
Young males%	0.992	0.936	1.052	0.975	0.919	1.035
Male/female%	1.013*	1.003	1.023	1.012*	1.002	1.023
Mean age	1.047	0.945	1.160	1.075	0.948	1.219
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Conversely, in the postcodes between 7km and 15km from the CBD (Table 7.25 - 145 observations), the count of off-premise outlets was positively associated with injury (each additional off-premise outlet was associated with up to a 13% increase in alcohol-related injuries).

Table 7.25: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes from 7km to 15km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.001	0.978	1.025	0.996	0.972	1.020
Count of off-premise outlets	1.133*	1.003	1.280	1.105	0.981	1.246
On-premise sales#/outlet	0.997	0.979	1.015	0.993	0.972	1.015
Off-premise sales#/outlet	1.002	0.985	1.018	0.997	0.977	1.018
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.051	0.880	1.254	1.042	0.846	1.282
SEIFA quartile 3	0.988	0.710	1.376	0.903	0.633	1.290
SEIFA quartile 4	1.101	0.766	1.584	1.010	0.687	1.485
Unemployment%	0.934*	0.913	0.955	0.924*	0.900	0.949
Indigenous%	1.258*	1.094	1.447	1.180*	1.021	1.364
Young males%	0.965	0.928	1.004	0.945*	0.904	0.989
Male/female%	1.000	0.984	1.016	1.005	0.989	1.022
Mean age	0.987*	0.977	0.997	0.986*	0.973	0.999
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Alcohol availability variables and alcohol-related injury were not significantly associated in postcodes situated more than 15km from the CBD (Table 7.26 -113 observations). The size of postcodes increases further from the CBD as population density decreases: this might explain the lack of significant associations for the smallest buffer zones from the geographic centroid.

Further significant predictors of alcohol-related injury in postcodes across the zones were: the proportion of residents of Indigenous origin (all zones from CBD) and proportion of males (up to 7km and more than 15km from the CBD).

Table 7.26: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes beyond 15km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
15km+ from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.987	0.960	1.015	0.989	0.959	1.020
Count of off-premise outlets	1.047	0.901	1.216	0.999	0.829	1.204
On-premise sales#/outlet	0.960	0.896	1.028	0.968	0.895	1.046
Off-premise sales#/outlet	1.012	0.991	1.034	1.013	0.990	1.037
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.968	0.863	1.085	1.035	0.919	1.166
SEIFA quartile 3	0.783	0.584	1.049	0.844	0.597	1.192
SEIFA quartile 4	1.003	0.752	1.338	1.053	0.737	1.505
Unemployment%	1.019	0.999	1.039	1.011	0.988	1.034
Indigenous%	1.426*	1.234	1.649	1.420*	1.189	1.695
Young males%	0.932*	0.890	0.976	0.925*	0.881	0.971
Male/female%	1.045*	1.026	1.065	1.041*	1.018	1.065
Mean age	1.082	1.000	1.172	1.091	0.990	1.203
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

The results for the statistical models including alcohol outlets within 2km on the geographic centroid by zone from the Perth CBD are shown in Tables 7.27 to 7.29. The model for postcodes between the CBD and 7km from the CBD (Table 7.27 - 160 observations) showed significant positive associations between counts of on-premise outlets and measures of alcohol-related injury (Night2 IRR: 1.009; Weekend Night2 IRR: 1.011).

Table 7.27: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes from the CBD to 7km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.009*	1.004	1.014	1.011*	1.006	1.017
Count of off-premise outlets	0.964	0.927	1.003	0.959*	0.921	0.999
On-premise sales#/outlet	0.973	0.914	1.035	0.993	0.924	1.068
Off-premise sales#/outlet	0.975	0.948	1.003	0.959*	0.926	0.994
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.705	0.496	1.003	0.735	0.519	1.041
SEIFA quartile 3	0.790	0.546	1.143	0.864	0.596	1.253
SEIFA quartile 4	0.785	0.528	1.167	0.843	0.560	1.269
Unemployment%	1.007	0.997	1.018	1.003	0.990	1.016
Indigenous%	1.109	0.980	1.257	1.114	0.980	1.267
Young males%	1.009	0.951	1.070	0.982	0.927	1.040
Male/female%	1.013*	1.002	1.024	1.011	1.000	1.021
Mean age	1.061	0.957	1.177	1.134*	1.003	1.282
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Alcohol availability variables and alcohol-related injury were not significantly associated in postcodes between 7km and 15km from the CBD (Table 7.28 - 241 observations).

Table 7.28: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes from 7km to15km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010	0.990	1.030	1.009	0.989	1.030
Count of off-premise outlets	1.018	0.972	1.067	1.016	0.968	1.066
On-premise sales#/outlet	1.011	0.979	1.045	1.018	0.980	1.056
Off-premise sales#/outlet	1.006	0.990	1.023	1.003	0.985	1.022
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.004	0.888	1.136	0.989	0.853	1.145
SEIFA quartile 3	0.853	0.680	1.068	0.874	0.687	1.111
SEIFA quartile 4	0.968	0.764	1.225	0.968	0.755	1.241
Unemployment%	0.961*	0.952	0.971	0.957*	0.945	0.968
Indigenous%	1.198*	1.103	1.301	1.159*	1.066	1.260
Young males%	0.958*	0.925	0.991	0.948*	0.912	0.985
Male/female%	0.991	0.977	1.006	1.001	0.986	1.015
Mean age	0.987*	0.977	0.998	0.986*	0.973	0.998
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

In postcodes beyond 15km from the CBD (Table 7.29 - 179 observations), an additional 10,000l of sales per on-premise outlet was associated with a 7.4% increase in Weekend Night2 injury risk, while counts of off-premise outlets were associated with an 18% decrease in risk of Weekend Night2 injury.

Postcodes beyond 7km from the CBD with higher proportions of unemployed and young male inhabitants were negatively associated with alcohol-related injury compared to postcodes in the lowest SEIFA. Postcodes beyond 15km with a higher proportion of residents of Indigenous origin were positively associated with alcohol-related injury. The proportion of males and mean age in postcodes had varying associations with injury in different zones from the CBD.

Table 7.29: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes beyond 15km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

15km+ from CBD	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.006	0.970	1.044	1.013	0.973	1.054
Count of off-premise outlets	0.845*	0.752	0.949	0.819*	0.725	0.926
On-premise sales#/outlet	1.069*	1.016	1.126	1.074*	1.017	1.134
Off-premise sales#/outlet	1.009	0.985	1.034	1.007	0.982	1.032
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.077	0.935	1.241	1.114	0.961	1.291
SEIFA quartile 3	0.908	0.688	1.199	0.978	0.731	1.308
SEIFA quartile 4	1.357	0.954	1.931	1.420	0.987	2.044
Unemployment%	1.022*	1.003	1.041	1.011	0.991	1.031
Indigenous%	1.371*	1.109	1.695	1.400*	1.128	1.739
Young males%	0.966	0.917	1.018	0.974	0.921	1.029
Male/female%	1.016	0.984	1.050	1.002	0.968	1.036
Mean age	1.419*	1.274	1.581	1.377*	1.233	1.536
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Tables 7.30 to 7.32 display the results of the statistical models using counts and sales of outlets situated within 5km of the geographic centroid of the postcode. Models for postcodes within 7km of the CBD (Table 7.30 - 160 observations) did not reveal significant associations between alcohol availability and alcohol-related injury. The exception was the significant negative association between on-premise sales per outlet and Weekend Night2 (but not Night2) injury. This model showed that an increase in 10,000l per on-premise outlet was associated with a 48% decreased risk of Weekend Night2 injuries; however, the confidence interval was wide.

Table 7.30: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes from the CBD to 7km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.998	1.001	0.999	0.997	1.001
Count of off-premise outlets	0.992	0.969	1.016	0.996	0.970	1.023
On-premise sales#/outlet	0.814	0.572	1.158	0.521*	0.334	0.813
Off-premise sales#/outlet	0.966	0.894	1.045	0.908	0.823	1.002
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.926	0.597	1.435	0.973	0.631	1.500
SEIFA quartile 3	1.049	0.665	1.655	1.126	0.709	1.789
SEIFA quartile 4	1.052	0.646	1.712	1.061	0.640	1.758
Unemployment%	1.003	0.992	1.015	0.995	0.981	1.008
Indigenous%	1.110	0.953	1.292	1.159	0.987	1.360
Young males%	1.006	0.937	1.081	0.982	0.908	1.062
Male/female%	1.028*	1.013	1.043	1.030*	1.015	1.046
Mean age	1.008	0.899	1.131	1.049	0.913	1.206
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Statistical models for postcodes in the zone between 7km to 15km (Table 7.31 - 259 observations) demonstrated that the count of on-premise outlets was associated with a small increase in risk of Night2 injuries (IRR: 1.003).

Table 7.31: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes from 7km to 15km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	1.000	1.005	1.002	0.999	1.004
Count of off-premise outlets	0.995	0.983	1.008	0.994	0.981	1.008
On-premise sales#/outlet	0.977	0.864	1.105	0.987	0.860	1.133
Off-premise sales#/outlet	1.014	0.983	1.045	1.004	0.969	1.040
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.972	0.865	1.092	0.968	0.847	1.106
SEIFA quartile 3	0.824	0.674	1.008	0.854	0.686	1.063
SEIFA quartile 4	0.895	0.719	1.115	0.929	0.733	1.177
Unemployment%	0.964*	0.953	0.974	0.957*	0.944	0.969
Indigenous%	1.144*	1.063	1.232	1.130*	1.044	1.223
Young males%	0.956*	0.924	0.989	0.946*	0.910	0.982
Male/female%	0.996	0.982	1.011	0.998	0.981	1.015
Mean age	0.988*	0.978	0.998	0.987*	0.974	0.999
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

In postcodes more than 15km from the CBD (Table 7.32 - 348 observations), an increase in 10,000l of sales per on-premise outlet was associated with a 16.3% increase in Weekend Night2 injuries, while an increase of one off-premise outlet per postcode was associated with a 4.7% decrease in risk of Weekend Night injury.

Postcodes within 7km of the CBD containing a higher proportion of males were significantly associated with higher risk of alcohol-related injury. Models for postcodes located beyond 7km from the CBD indicated positive associations between alcohol-related injuries and the proportion of Indigenous residents in the postcode, but negative associations with mean age and proportion on unemployed inhabitants.

Table 7.32: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes beyond 15km from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
15km+ from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	1.000	1.005	1.002	1.000	1.005
Count of off-premise outlets	0.946*	0.923	0.969	0.953*	0.929	0.978
On-premise sales#/outlet	1.074	0.951	1.212	1.163*	1.023	1.322
Off-premise sales#/outlet	1.018	0.996	1.041	1.022	0.998	1.047
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.974	0.864	1.098	1.013	0.890	1.152
SEIFA quartile 3	0.862	0.718	1.036	0.867	0.713	1.055
SEIFA quartile 4	1.192	0.937	1.517	1.166	0.901	1.509
Unemployment%	0.998	0.984	1.012	0.987	0.971	1.003
Indigenous%	1.024*	1.016	1.033	1.021*	1.011	1.031
Young males%	0.996	0.956	1.037	1.008	0.966	1.052
Male/female%	0.997	0.988	1.006	0.994	0.984	1.005
Mean age	1.349*	1.258	1.447	1.305*	1.204	1.415
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Statistical models controlling for distance from CBD

In the statistical models in this section, distance from the CBD was treated as a categorical variable. The zone of postcodes (and suburbs) beyond 15km from the CBD was the reference group as this was the largest group (containing 489 of 936 postcodes and 1,621 of a total of 2,740 suburbs over the eight year period). The four tables below demonstrate the models: for all sales and outlet counts (Table 7.33), for those within 1km (Table 7.34), within 2km (Table 7.35) and within 5km (Table 7.36) of the geographic centroid of the postcode.

In Table 7.33, the models included the total outlet counts and sales per outlet in each postcode. The models showed positive significant relationships between the count of on-premise outlets and alcohol-related injury: the addition of an on-premise outlet was associated with a 1.2% increase of Weekend Night2 injury. Models demonstrated positive significant associations with off-premise sales per outlet: an increase in 10,000l of off-premise sales per outlet was significantly associated with a 1.9% increase in Night2 and Weekend Night2 injuries. Interestingly, an additional off-premise outlet at postcode-level was associated with a 4.6% drop in Weekend Night2 injuries– given that the reference zone was postcodes 15km from the CBD, this may have been related to additional off-premise outlets resulting in less driving and so lower exposure to alcohol-related road crashes. The postcodes between the CBD and 7km from the CBD were positively associated with Night2 injury (IRR: 1.359). Postcodes in the highest SEIFA category and with a high proportion of Indigenous residents were significantly positively associated with alcohol-related injury.

Table 7.33: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.009*	1.005	1.014	1.012*	1.008	1.017
Count of off-premise outlets	0.945*	0.919	0.973	0.956*	0.930	0.982
On-premise sales#/outlet	1.035	0.990	1.082	1.039	0.991	1.088
Off-premise sales#/outlet	1.019*	1.004	1.034	1.019*	1.004	1.035
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.971	0.829	1.139	0.883	0.772	1.009
CBD to 7km	1.359*	1.102	1.675	1.095	0.926	1.295
CBD	0.970	0.362	2.601	0.459	0.200	1.052
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.990	0.900	1.089	1.009	0.914	1.114
SEIFA quartile 3	1.054	0.917	1.212	1.025	0.889	1.183
SEIFA quartile 4	1.352*	1.125	1.625	1.240*	1.024	1.503
Unemployment%	0.983*	0.973	0.993	0.975*	0.963	0.986
Indigenous%	1.298*	1.221	1.379	1.257*	1.181	1.338
Young males%	0.967*	0.946	0.990	0.967*	0.945	0.990
Male/female%	0.986*	0.979	0.993	0.988*	0.981	0.995
Mean age	0.991	0.981	1.001	0.991	0.980	1.003
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

When the relationships between alcohol-related injury and outlet counts and sales within 1km of the geographic centroid of the postcode were modelled (Table 7.34), the count of on-premise outlets was positively and significantly associated with Weekend Night2 injury: the addition of an on-premise outlet was associated with an increase in 0.9% in Weekend Night2 injuries. High proportions of Indigenous residents in postcodes were strongly associated with higher risk of injury, as were lower proportions of unemployed and young male inhabitants in a postcode.

Table 7.34: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.003	1.011	1.009*	1.004	1.013
Count of off-premise outlets	0.989	0.926	1.057	0.989	0.925	1.057
On-premise sales#/outlet	0.998	0.979	1.018	0.994	0.973	1.016
Off-premise sales#/outlet	1.003	0.990	1.015	1.003	0.990	1.017
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.858	0.733	1.004	0.830*	0.712	0.967
CBD to 7km	0.963	0.808	1.149	0.858	0.728	1.010
CBD	0.316*	0.128	0.780	0.186*	0.082	0.423
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.022	0.943	1.107	1.070	0.980	1.169
SEIFA quartile 3	0.968	0.827	1.133	1.005	0.851	1.186
SEIFA quartile 4	1.166	0.976	1.394	1.177	0.974	1.422
Unemployment%	0.983*	0.971	0.994	0.975*	0.962	0.987
Indigenous%	1.217*	1.129	1.313	1.214*	1.121	1.314
Young males%	0.936*	0.914	0.958	0.937*	0.915	0.961
Male/female%	1.010*	1.001	1.019	1.010*	1.001	1.019
Mean age	0.989*	0.979	0.999	0.988	0.976	1.000
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Models using a 2km buffer from the relevant geographic centroid (Table 7.35) suggested a positive significant association between alcohol-related injury and count of on-premise outlets at postcode-level: one additional on-premise outlet was associated with a 1% increase in Weekend Night2 injuries. Further, an additional 10,000l of sales per on-premise outlet was associated with an increase of 3.5% in Night2 injuries and of 3.6% in Weekend Night2 injuries. Postcodes in the highest SEIFA category and with a higher proportion of Indigenous inhabitants were at significantly higher risk of alcohol-related injury, as were lower proportion of unemployed and young male residents.

Table 7.35: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.001	1.013	1.010*	1.005	1.015
Count of off-premise outlets	0.997	0.964	1.031	0.988	0.958	1.020
On-premise sales#/outlet	1.035*	1.006	1.064	1.036*	1.007	1.066
Off-premise sales#/outlet	1.008	0.994	1.023	1.007	0.992	1.021
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.050	0.856	1.287	0.879	0.758	1.021
CBD to 7km	1.361*	1.023	1.809	1.020	0.835	1.246
CBD	0.635	0.173	2.323	0.246*	0.092	0.660
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.000	0.909	1.101	1.027	0.930	1.133
SEIFA quartile 3	0.969	0.825	1.138	0.986	0.840	1.157
SEIFA quartile 4	1.282*	1.056	1.556	1.232*	1.013	1.498
Unemployment%	0.974*	0.966	0.981	0.969*	0.961	0.978
Indigenous%	1.313*	1.214	1.421	1.269*	1.177	1.367
Young males%	0.972*	0.946	0.999	0.965*	0.940	0.992
Male/female%	0.996	0.984	1.007	0.999	0.989	1.009
Mean age	1.000	0.990	1.011	1.001	0.989	1.013
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Finally, models using a 5km buffer around the geographic centroid (Table 7.36) indicated that an increase in 10,000l of off-premise sales was associated with a 3.3% increase in Weekend Night2 injuries. A high proportion of Indigenous residents in a postcode was significantly positively associated with alcohol-related injury. The CBD was strongly associated with increased risk of alcohol-related injury.

Table 7.36: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	0.996	0.984	1.008	1.000	0.988	1.011
On-premise sales#/outlet	1.047	0.961	1.141	1.109*	1.015	1.212
Off-premise sales#/outlet	1.032*	1.014	1.050	1.033*	1.013	1.052
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.072	0.888	1.294	0.950	0.804	1.123
CBD to 7km	1.560*	1.127	2.161	1.229	0.931	1.622
CBD	2.909*	1.345	6.292	2.063*	1.011	4.209
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.903*	0.829	0.983	0.924	0.845	1.011
SEIFA quartile 3	0.765*	0.675	0.866	0.763*	0.673	0.865
SEIFA quartile 4	0.955	0.817	1.116	0.922	0.787	1.080
Unemployment%	0.971*	0.963	0.978	0.965*	0.957	0.973
Indigenous%	1.024*	1.017	1.030	1.021*	1.013	1.028
Young males%	0.980	0.957	1.004	0.983	0.959	1.008
Male/female%	0.999	0.993	1.006	0.999	0.993	1.006
Mean age	1.006	0.996	1.016	1.004	0.993	1.016
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.8 Comparison between postcode and suburb models

The postcode models including all outlets and their sales in each postcode, all socio-demographic variables and zones from the CBD (718 observations) were compared to the equivalent suburb models (790 observations) for 2002/03 to 2009/10 in Table 7.37. The associations between alcohol availability variables and measures of alcohol-related injury were similar for postcode and suburb models: counts of on-premise outlets and sales per off-premise outlet were significantly associated with measures of alcohol-related injury. Counts of off-premise outlets were significantly negatively associated with alcohol-related injury at postcode, but not at suburb-level.

On the whole, effect sizes were slightly smaller and confidence intervals were wider in suburb models. The latter observation could be explained by the smaller geographical size of outer suburbs[61] and consequent statistical lower power of these models. This might be partly compensated for by the larger number of panels in the models in the suburb models (as there are more suburbs than postcodes in the Perth Metropolitan Area).

As has been discussed earlier in this chapter, data was missing or zero in several suburbs, and suburb definitions were less consistent than postcode definitions across the different data sets. The postcode-level data was more consistent and accurate and so the rest of the models in this chapter used postcode as the geographic unit of analysis.

[61] Postcodes cover much smaller areas near more densely populated areas and the CBD [427], approximating suburbs, but outer postcodes might contain three or more suburbs.

Table 7.37: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, by postcode- and suburb-level, between 2002/03 and 2009/10

	Postcode			Suburb			Postcode			Suburb		
	Night2 injuries						Weekend Night2 injuries					
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.009*	1.005	1.014	1.003	0.998	1.009	1.012*	1.008	1.017	1.006	1.000	1.012
Count of off-premise outlets	0.945*	0.919	0.973	0.999	0.949	1.051	0.956*	0.930	0.982	1.007	0.957	1.060
On-premise sales#/outlet	1.035	0.990	1.082	0.995	0.964	1.026	1.039	0.991	1.088	0.991	0.957	1.025
Off-premise sales#/outlet	1.019*	1.004	1.034	1.021*	1.004	1.038	1.019*	1.004	1.035	1.017	0.999	1.035
15km+ from CBD^	1.000			1.000			1.000			1.000		
7km to 15km from CBD	0.971	0.829	1.139	0.965	0.844	1.103	0.883	0.772	1.009	0.897	0.791	1.018
CBD to 7km	1.359*	1.102	1.675	1.112	0.929	1.331	1.095	0.926	1.295	0.942	0.796	1.115
CBD	0.970	0.362	2.601	0.821	0.309	2.183	0.459	0.200	1.052	0.427	0.158	1.157
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.990	0.900	1.089	1.083	0.949	1.237	1.009	0.914	1.114	1.165*	1.010	1.343
SEIFA quartile 3	1.054	0.917	1.212	1.112	0.943	1.311	1.025	0.889	1.183	1.180	0.992	1.403
SEIFA quartile 4	1.352*	1.125	1.625	1.143	0.946	1.381	1.240*	1.024	1.503	1.204	0.987	1.468
Unemployment%	0.983*	0.973	0.993	1.141*	1.104	1.178	0.975*	0.963	0.986	1.142*	1.105	1.181
Indigenous%	1.298*	1.221	1.379	1.072*	1.031	1.115	1.257*	1.181	1.338	1.063*	1.020	1.108
Young males%	0.967*	0.946	0.990	0.984	0.953	1.016	0.967*	0.945	0.990	0.982	0.950	1.014
Male/female%	0.986*	0.979	0.993	0.998	0.997	1.000	0.988*	0.981	0.995	0.999	0.997	1.001
Mean age	0.991	0.981	1.001	1.040*	1.020	1.060	0.991	0.980	1.003	1.026*	1.006	1.045
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.9 Comparison between two time series

As discussed in Chapter four and earlier in this chapter, data was analysed using two time series: 2002/03 to 2009/10, and 2004/05 to 2009/10. The former dataset was missing ED presentations for the Joondalup Health Campus from July 2002 to July 2004. The 2004/05 dataset contained data from all Perth public hospitals but statistical models using this dataset had considerably less statistical power as the dataset contained fewer panels or units of analysis (six years multiplied by the number of postcodes, compared to eight years multiplied by the number of postcodes – effectively 25% fewer panels in the shorter time period). Models using the smaller dataset were therefore less likely to identify true associations between alcohol availability variables (and other predictors), and measures of alcohol-related injury (i.e. Type II errors).

A comparison between the two time periods is presented in Table 7.38 below. The models for the longer time period contained 718 observations, while the shorter time period contained 543 observations. Across both time periods and measures of alcohol-related injury, counts of on-premise outlets were significantly associated with alcohol-related injury. Sales per off-premise outlets were significantly associated with Night2 and Weekend Night2 injury between 2002/03 and 2009/10. The associations were in the same direction but not significant for the 2004/05 to 2009/10 time period. Previous research has indicated a significant positive association between off-premises sales and harms [22, 23, 365], suggesting that the model using the longer time series had elicited a true association. Counts of off-premise outlets were significantly negatively associated with harms in the longer time series. The associations were in the same direction but not significant for the shorter time series.

Similarly, for the socio-economic and demographic postcode-level predictors, associations were in the same direction for both time periods but were not significant for the 2004/05 time period.

As the significant associations in the longer time series concurred with previous alcohol sales literature and had substantially more statistical power, the longer time series was used for the main analyses, and the models for the shorter time series were displayed in the Appendix (10.10).

Table 7.38: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, by postcode-level, comparing two time periods between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.009*	1.005	1.014	1.008*	1.005	1.012	1.012*	1.008	1.017	1.011*	1.008	1.014
Count of off-premise outlets	0.945*	0.919	0.973	0.985	0.965	1.006	0.956*	0.930	0.982	0.983	0.963	1.004
On-premise sales#/outlet	1.035	0.990	1.082	1.016	0.985	1.048	1.039	0.991	1.088	1.008	0.973	1.044
Off-premise sales#/outlet	1.019*	1.004	1.034	1.007	0.997	1.018	1.019*	1.004	1.035	1.005	0.993	1.017
15km+ from CBD^	1.000			1.000			1.000			1.000		
7km to 15km from CBD	0.971	0.829	1.139	0.797*	0.704	0.903	0.883	0.772	1.009	0.814*	0.725	0.913
CBD to 7km	1.359*	1.102	1.675	0.915	0.793	1.056	1.095	0.926	1.295	0.862*	0.754	0.985
CBD	0.970	0.362	2.601	0.508*	0.266	0.971	0.459	0.200	1.052	0.306*	0.166	0.564
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.990	0.900	1.089	0.973	0.912	1.038	1.009	0.914	1.114	0.983	0.913	1.059
SEIFA quartile 3	1.054	0.917	1.212	0.949	0.861	1.045	1.025	0.889	1.183	0.942	0.848	1.046
SEIFA quartile 4	1.352*	1.125	1.625	0.959	0.840	1.094	1.240*	1.024	1.503	0.917	0.798	1.054
Unemployment%	0.983*	0.973	0.993	1.002	0.996	1.008	0.975*	0.963	0.986	0.999	0.992	1.006
Indigenous%	1.298*	1.221	1.379	1.110*	1.059	1.163	1.257*	1.181	1.338	1.101*	1.049	1.156
Young males%	0.967*	0.946	0.990	0.990	0.967	1.014	0.967*	0.945	0.990	0.980	0.956	1.004
Male/female%	0.986*	0.979	0.993	0.996	0.991	1.002	0.988*	0.981	0.995	0.998	0.992	1.003
Mean age	0.991	0.981	1.001	1.009	0.982	1.036	0.991	0.980	1.003	0.993	0.968	1.018
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.10 Models with zones by median distance between traffic signals

Luk and colleagues determined the zones from the Perth CBD based on several factors discussed in 4.7.1 [435]. The authors define the zones in terms of the distance between controlled intersections (the link length), so that: the link distance within the CBD was up to 300m; the link distance in the inner suburbs was 300m to 1,000m; in the middle suburbs it was 1,000m to 1,500m; and in the outer suburbs, the link distance was greater than 1,500m (see 7.3.7). *"Directions 2031 and Beyond"* [454], the most recent metropolitan planning strategic framework[62], describes the Perth Metropolitan Areas as having several strategic metropolitan areas: Armadale, Cannington, Fremantle, Joondalup, Morley, Midland, Stirling and Rockingham. These areas contain retail, office, community, entertainment, residential and employment activities, and frequent public transport. As business and retail 'centres' with characteristics in common with the main Perth CBD (such as road network structure and clustering of retail outlets, including alcohol outlets), it was hypothesised that certain centres might 'behave' similarly to the CBD and surrounding suburbs, despite being located further from the CBD.

Using current road network and traffic signal shapefiles provided by Main Roads [438], the median distance between traffic signals was calculated for each postcode (and suburb – see 10.10.4), and then postcodes (and suburbs) were allocated to a traffic signal zone. The traffic signal zone was an alternative categorical variable to 'zone from the CBD' in the models. The reference group was the postcodes with link distances of 1,500m or more (344 of a total of 936 postcodes over the eight year period). The other three categories were postcodes with link distances of 1,000m to 1,500m (40 observations), 300m to 1,000m (432 observations) and up to 300m (120 observations). Several of the models failed to converge, and generally the models were poorer than those using the CBD zones as defined by Luk et al. [435]. The models may have been limited by the use of current road network and traffic signal shapefiles, rather than separate shapefiles for each financial year.

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[62] Directions 2031 and Beyond [454]replaces the Stephenson-Hepburn Plan (1955), the Corridor Plan (1970), Metroplan (1990) and Network City (2004)

Stratifying by median distance between traffic signals

Models stratifying for median traffic signal distance were constructed. The number of observations for each zone for each model type is indicated in Table 7.39 below.

Table 7.39: Number of observations for each model type by zone of median distance between traffic signals, by postcode and financial year, in Perth Metropolitan Area between 2002/03 to 2009/10

	Count of observations			
Median distance between traffic signals	All outlets	1km buffer	2km buffer	5km buffer
Less than 300m	112	96	112	120
300m to 1,000m	402	278	367	402
1,000m to 1,500m	Models did not converge			
1,500m or more	172	32	69	213

The statistical models for postcodes with median link distances of less than 300m showed positive, significant associations between measures of injury and counts of on-premise outlets for models with no buffer zones, and 1km and 2km buffers from the postcode centroid (see Tables 7.40, 7.43 and 7.46).

The non-buffer models (Tables 7.40 to 7.42) indicated that one additional on-premise outlet was significantly associated with a 1.2% increase in Weekend Night2 and a 1.1% increase in Night2 injuries in postcodes with median link distances of 300m to 1,000m (Table 7.41), and a stronger significant association in postcodes with median link distances of greater than 1,500m (Table 7.42 - Night2 IRR: 1.080). The non-buffer model for postcodes with link distances of between 1000m to 1500m did not converge.

Table 7.40: Panel model results for sales and counts of on- and off-premise outlets, for postcodes with a median distance of up to 300m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.011*	1.006	1.015	1.012*	1.007	1.017
Count of off-premise outlets	0.875*	0.801	0.954	0.919	0.823	1.026
On-premise sales#/outlet	1.006	0.937	1.080	0.990	0.904	1.083
Off-premise sales#/outlet	0.998	0.959	1.038	0.996	0.947	1.048
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.169	0.539	2.536	1.286	0.531	3.115
SEIFA quartile 3	0.794	0.451	1.395	0.772	0.405	1.470
SEIFA quartile 4	0.768	0.419	1.409	0.665	0.328	1.347
Unemployment%	0.975*	0.955	0.996	0.972*	0.946	0.999
Indigenous%	1.118	0.857	1.459	1.017	0.727	1.423
Young males%	1.196*	1.091	1.311	1.191*	1.057	1.343
Male/female%	0.981*	0.965	0.998	0.979*	0.959	0.999
Mean age	1.113	0.962	1.288	1.103	0.919	1.324
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.41: Panel model results for sales and counts of on- and off-premise outlets, for postcodes with a median distance of 300m to 1,000m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.008*	1.002	1.014	1.009*	1.004	1.014
Count of off-premise outlets	0.970	0.941	1.000	0.972	0.944	1.001
On-premise sales#/outlet	1.056*	1.004	1.110	1.053	0.998	1.111
Off-premise sales#/outlet	1.014	0.993	1.035	1.015	0.993	1.038
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.997	0.881	1.128	1.023	0.898	1.165
SEIFA quartile 3	1.099	0.913	1.324	1.097	0.905	1.328
SEIFA quartile 4	1.317*	1.043	1.664	1.250	0.981	1.594
Unemployment%	0.995	0.985	1.005	0.989	0.977	1.000
Indigenous%	1.303*	1.204	1.410	1.258*	1.159	1.366
Young males%	0.925*	0.895	0.956	0.931*	0.901	0.961
Male/female%	0.987	0.973	1.001	0.994	0.980	1.008
Mean age	0.999	0.979	1.020	0.998	0.977	1.019
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.42: Panel model results for sales and counts of on- and off-premise outlets, for postcodes with a median distance of 1,500m or more between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.080*	1.042	1.119	1.077*	1.034	1.122
Count of off-premise outlets	0.899*	0.823	0.983	0.944	0.853	1.046
On-premise sales#/outlet	1.081	0.945	1.236	1.086	0.933	1.265
Off-premise sales#/outlet	1.014	0.994	1.035	1.009	0.985	1.034
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.964	0.841	1.105	0.988	0.847	1.151
SEIFA quartile 3	0.888	0.715	1.103	0.898	0.706	1.142
SEIFA quartile 4	1.564*	1.042	2.347	1.620*	1.021	2.571
Unemployment%	0.960*	0.927	0.995	0.952*	0.916	0.989
Indigenous%	1.202*	1.034	1.397	1.243*	1.035	1.492
Young males%	1.021	0.982	1.062	1.011	0.967	1.056
Male/female%	0.983*	0.968	0.998	0.981*	0.964	0.999
Mean age	1.094	0.958	1.248	1.138	0.974	1.329
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.43: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes with a median distance of up to 300m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010*	1.006	1.015	1.012*	1.006	1.017
Count of off-premise outlets	0.874*	0.790	0.967	0.900	0.785	1.031
On-premise sales#/outlet	1.010	0.963	1.059	1.003	0.943	1.066
Off-premise sales#/outlet	1.009	0.959	1.061	1.024	0.959	1.093
SEIFA quartile 1^	1.000				1.000	
SEIFA quartile 2	1.000				1.000	
SEIFA quartile 3	0.595	0.313	1.130	0.550	0.270	1.120
SEIFA quartile 4	0.547	0.272	1.101	0.443*	0.201	0.973
Unemployment%	0.989	0.973	1.004	0.986	0.966	1.006
Indigenous%	1.010	0.754	1.354	0.889	0.609	1.296
Young males%	1.274*	1.144	1.420	1.276*	1.113	1.463
Male/female%	0.971*	0.952	0.991	0.969*	0.946	0.992
Mean age	1.016	0.873	1.184	1.030	0.851	1.247
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.44: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes with a median distance of between 300m and 1,000m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.001	0.985	1.017	1.001	0.984	1.018
Count of off-premise outlets	0.956	0.869	1.052	0.925	0.835	1.026
On-premise sales#/outlet	1.002	0.981	1.023	0.998	0.975	1.022
Off-premise sales#/outlet	1.003	0.988	1.019	1.004	0.987	1.022
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.033	0.933	1.145	1.064	0.950	1.192
SEIFA quartile 3	0.932	0.769	1.131	0.932	0.754	1.152
SEIFA quartile 4	1.103	0.889	1.368	1.106	0.875	1.398
Unemployment%	1.001	0.990	1.013	0.994	0.982	1.006
Indigenous%	1.223*	1.107	1.351	1.207*	1.086	1.341
Young males%	0.939*	0.912	0.967	0.942*	0.914	0.971
Male/female%	1.017*	1.002	1.032	1.022*	1.007	1.038
Mean age	1.133*	1.064	1.208	1.116*	1.046	1.191
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.45: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes with a median distance of 1,500m or more between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.159*	1.005	1.337	1.113	0.946	1.308
Count of off-premise outlets	1.214	0.938	1.571	1.284	0.960	1.718
On-premise sales#/outlet	1.382	0.942	2.027	1.258	0.809	1.956
Off-premise sales#/outlet	1.004	0.984	1.025	1.000	0.976	1.024
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.839	0.697	1.010	0.926	0.748	1.148
SEIFA quartile 3	1.000			1.000		
SEIFA quartile 4	1.450	0.942	2.232	1.948*	1.132	3.352
Unemployment%	0.976	0.932	1.023	0.995	0.940	1.053
Indigenous%	1.399	0.976	2.007	1.436	0.956	2.156
Young males%	0.848	0.678	1.061	0.848	0.655	1.098
Male/female%	0.929	0.842	1.024	0.860*	0.762	0.969
Mean age	1.117	0.980	1.273	1.212*	1.031	1.424
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.46: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes with a median distance of up to 300m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.008*	1.004	1.013	1.009*	1.003	1.014
Count of off-premise outlets	0.967	0.916	1.021	0.991	0.933	1.053
On-premise sales#/outlet	0.974	0.909	1.044	0.978	0.895	1.070
Off-premise sales#/outlet	1.007	0.956	1.062	0.991	0.926	1.060
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.898	0.337	2.394	1.077	0.411	2.825
SEIFA quartile 3	0.603	0.289	1.260	0.593	0.288	1.221
SEIFA quartile 4	0.562	0.257	1.228	0.499	0.225	1.107
Unemployment%	0.984	0.968	1.000	0.980	0.961	1.000
Indigenous%	1.024	0.771	1.361	0.942	0.656	1.353
Young males%	1.223*	1.103	1.356	1.227*	1.077	1.398
Male/female%	0.981	0.963	1.000	0.976*	0.955	0.998
Mean age	1.124	0.964	1.310	1.100	0.912	1.326
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.47: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes with a median distance of 300m to 1,000m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.998	0.979	1.017	1.004	0.984	1.025
Count of off-premise outlets	0.971	0.924	1.020	0.939*	0.889	0.993
On-premise sales#/outlet	1.024	0.989	1.059	1.034	0.996	1.073
Off-premise sales#/outlet	1.000	0.983	1.017	0.996	0.978	1.015
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.979	0.877	1.092	1.013	0.899	1.143
SEIFA quartile 3	0.878	0.730	1.057	0.917	0.748	1.126
SEIFA quartile 4	1.022	0.824	1.267	1.071	0.845	1.359
Unemployment%	0.989*	0.979	0.998	0.983*	0.973	0.994
Indigenous%	1.199*	1.077	1.335	1.206*	1.072	1.356
Young males%	0.955*	0.922	0.988	0.956*	0.921	0.992
Male/female%	1.005	0.989	1.021	1.004	0.987	1.022
Mean age	1.244*	1.165	1.330	1.232*	1.144	1.327
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.48: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes with a median distance of 1,000m to 1,500m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 1,000m to 1,500m between traffic signals	Night2 injuries			Weekend Night2 injuries	
Within 2km of centroid	IRR	95% CI		IRR	95% CI
Count of on-premise outlets	1.217	0.988	1.498	Not converge	
Count of off-premise outlets	0.934	0.806	1.083		
On-premise sales#/outlet	1.012	0.831	1.234		
Off-premise sales#/outlet	1.015	0.962	1.070		
SEIFA quartile 1^	1.000				
SEIFA quartile 2	1.000				
SEIFA quartile 3	0.338	0.042	2.714		
SEIFA quartile 4	1.607	0.229	11.291		
Unemployment%	0.956	0.908	1.007		
Indigenous%	1.543	0.706	3.368		
Young males%	1.096	0.874	1.375		
Male/female%	0.881*	0.829	0.936		
Mean age	0.987*	0.977	0.998		
ERP 15+	(exposure)				

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.49: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes with a median distance of beyond 1,500m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.142	0.974	1.338	1.173*	1.007	1.368
Count of off-premise outlets	0.739	0.523	1.046	0.714*	0.512	0.998
On-premise sales#/outlet	1.010	0.925	1.102	1.006	0.920	1.099
Off-premise sales#/outlet	1.002	0.980	1.025	1.000	0.976	1.024
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.948	0.773	1.163	0.974	0.794	1.195
SEIFA quartile 3	1.016	0.688	1.500	1.004	0.693	1.455
SEIFA quartile 4	2.012*	1.179	3.432	1.952*	1.180	3.230
Unemployment%	1.000	0.954	1.049	1.000	0.955	1.047
Indigenous%	1.083	0.878	1.335	1.113	0.910	1.361
Young males%	1.156	0.973	1.373	1.115	0.933	1.333
Male/female%	0.912*	0.837	0.995	0.886*	0.813	0.967
Mean age	1.184*	1.020	1.373	1.168*	1.022	1.335
ERP 15+	(exposure)					

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

In models including outlets within 5km of the postcode centroid, an increase in 10,000l of on-premise sales was associated with a 23% increase in Weekend Night2 injury, in postcodes with a median link distance of more than 1,500m (Table 7.53). An additional on-premise outlet was associated with a 2.8% increase in Night2 injuries while an additional off-premise outlet was associated with a 7.6% decrease in Night2 injuries. Other zones of link distance were demonstrated similar or weaker associations than the CBD zone models.

In all models for median link distance up to 300m (Table 7.50), postcodes with a higher proportion of young males were positively associated with alcohol-related injury. Models for postcodes with link distances between 300m and 1,000m (Table 7.51) indicated a positive association between postcodes with higher proportion of those of Indigenous origin and higher mean age, and alcohol-related injury. In models for median link distance of more than 1,500m (Table 7.53), several socio-demographic factors were positively associated with alcohol-related injury, particularly postcodes in the highest SEIFA category.

Table 7.50: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes with a median distance of up to 300m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.998	1.001	0.999	0.997	1.001
Count of off-premise outlets	1.003	0.980	1.027	1.006	0.978	1.034
On-premise sales#/outlet	0.705*	0.497	0.999	0.582*	0.376	0.901
Off-premise sales#/outlet	0.975	0.866	1.098	0.903	0.775	1.052
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.884	0.403	1.941	1.133	0.542	2.371
SEIFA quartile 3	0.693	0.332	1.449	0.793	0.408	1.544
SEIFA quartile 4	0.766	0.356	1.650	0.834	0.412	1.691
Unemployment%	0.976*	0.957	0.995	0.960*	0.939	0.982
Indigenous%	1.112	0.813	1.523	1.238	0.850	1.802
Young males%	1.163*	1.040	1.300	1.159*	1.010	1.330
Male/female%	0.998	0.981	1.016	0.996	0.977	1.016
Mean age	1.035	0.902	1.188	0.975	0.834	1.140
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.51: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes with a median distance of 300m to 1,000m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.001	0.999	1.002	1.001	1.000	1.002
Count of off-premise outlets	0.990	0.975	1.006	0.982*	0.967	0.998
On-premise sales#/outlet	1.058	0.950	1.178	1.114	0.993	1.251
Off-premise sales#/outlet	1.014	0.984	1.045	1.011	0.978	1.044
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.984	0.886	1.093	1.019	0.910	1.142
SEIFA quartile 3	0.889	0.750	1.052	0.918	0.766	1.101
SEIFA quartile 4	1.034	0.844	1.267	1.055	0.847	1.314
Unemployment%	0.989*	0.980	0.998	0.983*	0.973	0.993
Indigenous%	1.245*	1.145	1.354	1.223*	1.119	1.337
Young males%	0.952*	0.923	0.983	0.955*	0.924	0.987
Male/female%	1.007	0.993	1.020	1.006	0.991	1.021
Mean age	1.170*	1.108	1.236	1.160*	1.093	1.231
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.52: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes with a median distance of 1,000m to 1,500m between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 1,000m to 1,500m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.006	0.985	1.026	1.000	0.978	1.021
Count of off-premise outlets	0.936	0.841	1.042	0.945	0.845	1.058
On-premise sales#/outlet	1.387	0.693	2.778	1.021	0.489	2.130
Off-premise sales#/outlet	1.022	0.945	1.105	0.981	0.901	1.067
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.000			1.000		
SEIFA quartile 3	0.420	0.092	1.913	0.517	0.103	2.597
SEIFA quartile 4	2.083	0.535	8.114	2.953	0.698	12.494
Unemployment%	0.922*	0.878	0.967	0.906*	0.861	0.955
Indigenous%	1.800*	1.098	2.950	2.003*	1.185	3.384
Young males%	1.005	0.835	1.210	1.051	0.867	1.273
Male/female%	0.934*	0.875	0.997	0.940	0.878	1.007
Mean age	0.984*	0.973	0.996	0.983*	0.970	0.997
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.53: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes with a median distance of 1,500m or more between traffic signals, adjusting for demographic and socio-economic status, in Perth Metropolitan Area between 2002/03 and 2009/10

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.028*	1.007	1.048	1.025*	1.003	1.048
Count of off-premise outlets	0.924*	0.881	0.969	0.933*	0.889	0.978
On-premise sales#/outlet	1.138	0.984	1.315	1.229*	1.054	1.434
Off-premise sales#/outlet	1.021*	1.002	1.039	1.020	0.999	1.041
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.912	0.797	1.044	0.921	0.791	1.074
SEIFA quartile 3	0.794*	0.655	0.962	0.755*	0.611	0.932
SEIFA quartile 4	1.311	0.971	1.769	1.162	0.859	1.573
Unemployment%	0.957*	0.937	0.978	0.938*	0.913	0.963
Indigenous%	1.026*	1.019	1.032	1.023*	1.015	1.031
Young males%	1.262*	1.164	1.368	1.251*	1.137	1.376
Male/female%	0.982*	0.974	0.990	0.983*	0.974	0.991
Mean age	0.977	0.904	1.056	0.942	0.878	1.010
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Statistical models controlling for median distance between traffic signals

Models controlled by zone of median link distance are presented below at postcode-level from 2002 to 2010 (Tables 7.54 to 7.57) and in the Appendix (10.10.4) for the shorter time series and at suburb-level. The models showed associations of similar directions to those controlling by zone from the CBD, but the associations were weaker and frequently either of borderline significance or not significant.

The strongest relationships were in the models using total counts of outlets and sales (Table 7.54). At postcode-level, significant associations were shown between Weekend Night2 injuries and both off-premise sales per outlet (IRR 1.020) and count of on-premise outlets (IRR: 1.009), while Weekend Night2 injuries were negatively associated with counts of off-premises outlets (IRR: 0.960). Night2 and Weekend Night2 injuries were also positively and significantly associated with the highest category of SEIFA and those postcodes with median link distance of up to 300m. Across both measures of alcohol related injury, postcodes with a higher proportion of residents of Indigenous origin were strongly associated with alcohol-related injury (Night2 IRR: 1.317, Weekend Night2 IRR: 1.288). Lower proportions of males and young males in a postcode were associated with higher risk of alcohol-related injury.

Table 7.54: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, and traffic signal zone, in Perth Metropolitan Area, by postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.009*	1.006	1.012	1.009*	1.006	1.013
Count of off-premise outlets	0.948*	0.921	0.976	0.960*	0.932	0.989
On-premise sales#/outlet	1.027	0.984	1.072	1.023	0.977	1.072
Off-premise sales#/outlet	1.019*	1.005	1.034	1.020*	1.004	1.036
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.592*	0.419	0.837	0.704*	0.505	0.981
300m-1,000m between signals	0.858	0.721	1.021	0.892	0.752	1.057
Up to 300m between signals	1.334*	1.049	1.697	1.225	0.970	1.547
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.996	0.908	1.092	1.026	0.929	1.132
SEIFA quartile 3	1.055	0.920	1.210	1.048	0.907	1.211
SEIFA quartile 4	1.359*	1.135	1.626	1.303*	1.079	1.574
Unemployment%	0.984*	0.974	0.994	0.976*	0.965	0.987
Indigenous%	1.317*	1.238	1.400	1.288*	1.206	1.374
Young males%	0.973*	0.951	0.995	0.970*	0.947	0.993
Male/female%	0.982*	0.975	0.989	0.984*	0.976	0.991
Mean age	0.994	0.983	1.005	0.992	0.980	1.004
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Postcode models for the three buffer zones from the centroid displayed similar but less significant associations between alcohol-related injury and alcohol availability variables, and similar associations with socio-demographic variables. Models including outlets within 1km of the geographic centroid (Table 7.55) demonstrated that an increase of one on-premise outlet was associated with a 0.4% increase in Weekend Night2 injury.

Table 7.55: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	0.999	1.007	1.004	1.000	1.008
Count of off-premise outlets	0.974	0.907	1.046	0.969	0.898	1.045
On-premise sales#/outlet	0.996	0.977	1.016	0.993	0.971	1.015
Off-premise sales#/outlet	1.005	0.992	1.017	1.004	0.990	1.018
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.756	0.468	1.221	0.870	0.542	1.398
300m-1,000m between signals	0.944	0.731	1.220	0.930	0.718	1.204
Up to 300m between signals	1.116	0.815	1.528	1.024	0.747	1.404
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.004	0.923	1.091	1.041	0.947	1.143
SEIFA quartile 3	0.936	0.793	1.105	0.969	0.809	1.160
SEIFA quartile 4	1.144	0.951	1.375	1.162	0.953	1.418
Unemployment%	0.991*	0.983	0.999	0.984*	0.975	0.993
Indigenous%	1.209*	1.116	1.311	1.198*	1.098	1.307
Young males%	0.937*	0.914	0.961	0.938*	0.913	0.963
Male/female%	1.006	0.996	1.016	1.006	0.996	1.017
Mean age	0.988*	0.978	0.999	0.987*	0.975	0.999
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Models including outlets within 2 km of the postcode geographic centroid (Table 7.56) demonstrated that an increase of 10,000l of on-premise sales was associated with an increase of 3.5% in risk of Weekend Night2 injury.

Table 7.56: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status, and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	1.000	1.007	1.005	1.000	1.009
Count of off-premise outlets	0.998	0.966	1.030	0.990	0.958	1.023
On-premise sales#/outlet	1.032*	1.004	1.062	1.035*	1.005	1.066
Off-premise sales#/outlet	1.009	0.995	1.023	1.007	0.993	1.022
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.711	0.499	1.012	0.747	0.530	1.054
300m-1,000m between signals	0.996	0.789	1.258	0.945	0.753	1.185
Up to 300m between signals	1.450*	1.043	2.016	1.250	0.913	1.713
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.999	0.910	1.096	1.024	0.927	1.131
SEIFA quartile 3	0.957	0.816	1.121	0.980	0.831	1.155
SEIFA quartile 4	1.277*	1.056	1.544	1.277*	1.047	1.557
Unemployment%	0.973*	0.965	0.981	0.968*	0.959	0.976
Indigenous%	1.323*	1.223	1.431	1.293*	1.191	1.403
Young males%	0.974	0.948	1.001	0.971*	0.944	0.999
Male/female%	0.995	0.983	1.006	0.995	0.983	1.007
Mean age	1.003	0.992	1.014	1.001	0.989	1.013
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

The models including the outlets 5km from the centroid (Table 7.57) demonstrated positive associations with alcohol availability variables: a 10,000l increase in alcohol sales at on-premise outlets with a 9.9% increase in Weekend Night2 injuries, and at off-premise outlets with a 3.4% increase in Night2 and Weekend Night2 injuries.

Table 7.57: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status, and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	1.004	0.993	1.015	1.000	0.990	1.012
On-premise sales#/outlet	1.038	0.954	1.131	1.099*	1.005	1.201
Off-premise sales#/outlet	1.034*	1.016	1.052	1.034*	1.015	1.054
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.586*	0.414	0.829	0.724*	0.525	0.999
300m-1,000m between signals	0.948	0.768	1.171	1.021	0.836	1.248
Up to 300m between signals	1.313	0.977	1.766	1.323	0.997	1.757
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.895*	0.823	0.973	0.923	0.844	1.009
SEIFA quartile 3	0.745*	0.660	0.843	0.754*	0.666	0.855
SEIFA quartile 4	0.935	0.803	1.087	0.919	0.787	1.074
Unemployment%	0.972*	0.965	0.979	0.966*	0.958	0.974
Indigenous%	1.024*	1.017	1.030	1.021*	1.014	1.029
Young males%	0.982	0.959	1.006	0.985	0.960	1.010
Male/female%	1.001	0.995	1.006	1.001	0.995	1.007
Mean age	1.011	0.999	1.022	1.006	0.994	1.018
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.11 Random effects vs fixed effects

The statistical models described in 7.2.7 included the zones from the CBD and socio-demographic factors as controlling variables, and used negative binomial regression with random effects. For comparison purposes, equivalent fixed effects models were constructed (reporting the coefficients rather than incidence rate ratios, as required by the Hausman test[63]) at postcode- and suburb-level for each buffer zone and for total postcode and suburb. The models used Night2 injury to represent alcohol-related injury. Both fixed effects postcode and suburb models including sales and outlets within 2km of the centroid did not converge.

[63] The Hausman test, as discussed in 4.7.1, is used to decide between models using random effects and fixed effects.

For each of the remaining six models, the Hausman test was performed in Stata to compare the each random and fixed effects model. The results for the Hausman tests were mixed, with some models producing significant and others producing insignificant test results.

There were computational issues with each of the six Hausman tests, with Stata returning the error message ‘not positive definite’, which could lead to an unreliable test result. While alternative tests existed to correct for this issue[64] for panel models with a normally distributed outcome variable (such as a continuous variable), there were no equivalent methods in Stata to adapt the test for an outcome variable with a negative binomial distribution. Because of the mixed results for the Hausman test on the different models, and potentially unreliable test results, they could not be used to decide between random effects and fixed effects models, and the decision was based on the context of the data.

Individual levels of fixed effects have specific values of interest. In contrast, individual-levels of random effects are not of interest in themselves, but rather are representative of a source of variation [381] The ‘levels’ of financial year and postcode were not of intrinsic importance in this data, and so functioned as random effects, rather than fixed effects, in the context of this study. Negative binomial regression with random effects was therefore used in the analyses in this study.

7.3.12 Models incorporating categories of trading hours

To compare differences in risk of alcohol-related injury between outlets with standard trading hours with outlets with extended trading hours, both on- and off-premise outlets were further divided by three categories of trading hours:

(a) Category one (etp1): outlets with weekend only extended trading hours;

(b) Category two (etp2): outlets with both weekday and weekend extended trading hours; and

(c) Category three (etp3): outlets with no extended trading hours.

The models were run using the three categories of trading hours at postcode-level. Due to the small number of outlets in etp1 (category one) and particularly etp2 (category two) at suburb-level, the models were not constructed at suburb-level. Variables including counts or

[64] An alternative which correct for errors in computation of the standard Hausman test is the robust Hausman test.

sales for those with all week extended trading hours were generally not significant (because of the very small number of outlets falling into this category and the resulting very wide confidence intervals) and are shown in the Appendix (10.10.5). The models were then run again combining categories one and two (outlets with *any* extended trading hours – 10.10.5). There was a low proportion of off-premise outlets with extended trading hours (more than 99% with normal trading hours – Table 7.58). Therefore, the final trading hours models categorised only on-premise outlets by trading hours, to improve the statistical power of the models. These models are shown in Tables 7.59 to 7.62 below.

Table 7.58: On- and off-premise outlets by category of trading hours, in Perth Metropolitan Area, in 2009/10

Trading hours category	Weekend ETP	Weekend and weekday ETP	No ETP	Total
	n (%)	n (%)	n (%)	n (%)
On-premise outlets	42 (2.4)	23 (1.3)	1,678 (96)	1,743 (100)
Off-premise outlets	2 (0.63)	0 (0)	316 (99)	318 (100)

The models including the outlets for the whole postcode showed positive associations between counts of on-premise and injury: the associations were stronger for those outlets with extended trading hours, as expected from previous research in Perth by Chikritzhs [30, 225, 226]. An increase of one on-premise outlet with extended trading hours was associated with a 4.9% increase in risk of Weekend Night2 injury, while an additional on-premise outlet with standard trading hours was associated with only a 0.8% increase in Weekend Night2 injury (Table 7.59). Interestingly, higher sales per on-premise outlets with standard trading hours were consistently associated with greater risk of alcohol-related injury than sales per on-premise outlet with extended trading hours. These associations were not significant for the total outlets, 1km and 2km models (Tables 7.59 to 7.61) but are significant for the 5km buffer models (Table 7.62).

Table 7.59: Panel model results for sales and counts of on- and off-premise outlets by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.046*	1.014	1.078	1.049*	1.015	1.084
Count of on-premise outlets (no extended trading hours)	1.006*	1.001	1.011	1.008*	1.004	1.013
Count of off-premise outlets	0.951*	0.924	0.979	0.961*	0.935	0.988
On-premise sales#/outlet (extended trading hours)	0.985	0.958	1.013	0.990	0.962	1.020
On-premise sales#/outlet (no extended trading hours)	1.022	0.985	1.060	1.023	0.984	1.063
Off-premise sales#/outlet	1.019*	1.005	1.033	1.019*	1.004	1.035
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.975	0.835	1.140	0.884	0.773	1.012
CBD to 7km	1.339*	1.093	1.639	1.086	0.919	1.283
CBD	1.017	0.392	2.637	0.515	0.226	1.172
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.995	0.908	1.091	1.017	0.924	1.119
SEIFA quartile 3	1.064	0.930	1.219	1.047	0.911	1.204
SEIFA quartile 4	1.370*	1.149	1.635	1.285*	1.067	1.547
Unemployment%	0.985*	0.975	0.994	0.977*	0.966	0.988
Indigenous%	1.291*	1.217	1.369	1.258*	1.183	1.337
Young males%	0.965*	0.944	0.987	0.964*	0.942	0.986
Male/female%	0.987*	0.981	0.994	0.989*	0.982	0.996
Mean age	0.991	0.981	1.001	0.991	0.979	1.002
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.60:.Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.039*	1.009	1.070	1.040*	1.005	1.076
Count of on-premise outlets (no extended trading hours)	1.006*	1.001	1.011	1.008*	1.003	1.013
Count of off-premise outlets	0.994	0.929	1.063	0.996	0.931	1.067
On-premise sales#/outlet (extended trading hours)	1.000	0.950	1.053	0.987	0.934	1.044
On-premise sales#/outlet (no extended trading hours)	1.005	0.987	1.023	1.001	0.981	1.021
Off-premise sales#/outlet	1.007	0.996	1.018	1.009	0.996	1.021
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.858*	0.737	0.997	0.834*	0.722	0.964
CBD to 7km	1.004	0.841	1.198	0.895	0.761	1.052
CBD	0.270*	0.105	0.692	0.161*	0.068	0.382
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.008	0.928	1.094	1.037	0.946	1.135
SEIFA quartile 3	1.054	0.917	1.212	1.061	0.913	1.233
SEIFA quartile 4	1.263*	1.072	1.489	1.230*	1.031	1.468
Unemployment%	0.991*	0.983	0.999	0.984*	0.976	0.993
Indigenous%	1.261*	1.173	1.356	1.241*	1.150	1.339
Young males%	0.937*	0.914	0.959	0.941*	0.918	0.965
Male/female%	1.005	0.996	1.015	1.005	0.996	1.014
Mean age	0.990	0.981	1.000	0.990	0.979	1.002
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 7.61: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.023	0.999	1.048	1.027*	1.001	1.054
Count of on-premise outlets (no extended trading hours)	1.002	0.999	1.005	1.003	1.000	1.006
Count of off-premise outlets	0.989	0.956	1.023	0.982	0.951	1.015
On-premise sales#/outlet (extended trading hours)	0.968	0.872	1.075	0.960	0.855	1.077
On-premise sales#/outlet (no extended trading hours)	1.039	0.999	1.079	1.037	0.996	1.081
Off-premise sales#/outlet	1.008	0.994	1.022	1.007	0.993	1.022
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.032	0.858	1.241	0.895	0.774	1.036
CBD to 7km	1.311*	1.016	1.691	1.032	0.848	1.255
CBD	1.045	0.440	2.481	0.591	0.289	1.207
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.993	0.906	1.089	1.017	0.924	1.119
SEIFA quartile 3	0.974	0.835	1.136	0.978	0.838	1.142
SEIFA quartile 4	1.290*	1.071	1.553	1.229*	1.017	1.484
Unemployment%	0.974*	0.966	0.982	0.969*	0.961	0.978
Indigenous%	1.326*	1.230	1.430	1.284*	1.192	1.382
Young males%	0.971*	0.946	0.997	0.967*	0.942	0.993
Male/female%	0.994	0.982	1.006	0.996	0.985	1.007
Mean age	1.000	0.989	1.010	1.000	0.988	1.011
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

The models incorporating outlets within 5km buffer zones showed no significant association between counts of on-premise outlets and measures of alcohol-related injury (Table 7.62 below). On-premise sales per outlet with standard trading hours were associated with a (significant) 13.3% increase in Night2 injury, while sales per outlets with ETPs were associated with a smaller, but not significant increase in risk of 6.3% (Table 7.62).

Table 7.62: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	0.997	0.988	1.005	0.998	0.988	1.007
Count of on-premise outlets (no extended trading hours)	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	0.993	0.982	1.005	0.995	0.983	1.006
On-premise sales#/outlet (extended trading hours)	1.063	0.937	1.206	1.051	0.914	1.210
On-premise sales#/outlet (no extended trading hours)	1.133*	1.025	1.252	1.172*	1.054	1.302
Off-premise sales#/outlet	1.031*	1.013	1.048	1.030*	1.011	1.049
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.070	0.888	1.291	0.965	0.815	1.144
CBD to 7km	1.579*	1.136	2.196	1.247	0.939	1.657
CBD	2.544*	1.179	5.489	1.890	0.931	3.837
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.904*	0.832	0.983	0.922	0.844	1.007
SEIFA quartile 3	0.762*	0.673	0.863	0.757*	0.667	0.858
SEIFA quartile 4	0.956	0.816	1.120	0.920	0.782	1.082
Unemployment%	0.971*	0.963	0.978	0.965*	0.957	0.973
Indigenous%	1.024*	1.018	1.030	1.021*	1.014	1.028
Young males%	0.981	0.959	1.005	0.985	0.960	1.009
Male/female%	1.001	0.998	1.004	1.000	0.997	1.004
Mean age	1.005	0.995	1.015	1.003	0.992	1.015
ERP 15+	(exposure)			(exposure)		

Sales in 10,000 litres * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

7.3.13 Models controlling for spatial autocorrelation

As discussed in 4.7.1, the frequentist spatial models which are currently available for panel data were designed for use with continuous dependent variables. However, the dependent or outcome variable in this study was a count of alcohol-related injuries (Night2 injuries and Weekend Night2 injuries). To explore the distribution of the outcome variables, two graphs were created: the first exploring the frequency of Night2 injuries and a second demonstrating the frequency of Weekend Night2 injuries per year per postcode. Both produced unimodal curves, skewed to the left and with a long tail to the right, and were visually similar to a negative binomial distribution. The outcome variables were transformed in several way (natural log, log to the base 10, inverse and square root), and the frequency of each transformed variable was plotted. None of the transformed variable had a distribution approximating a normal distribution. This strongly suggested that using spatial models for continuous data was not ideal for this dataset. Therefore, developing these models (available in MATLAB) was effectively a sensitivity analysis: the size of coefficients for the spatial and aspatial models could not be directly compared, but the direction and significance of coefficients could be.

Model with total counts of outlet and sales per outlet per postcode

Global Moran's I for outlets and sales for the total postcodes are indicated in Table 7.63. The test used a spatial weights matrix using the queen's contiguity method. Moran's I was significant for all financial years except 2002/03 using the residuals from both the Night2 and Weekend Night2 injury models. These results indicated that positive spatial autocorrelation was present in most of the data and consequently spatial models were developed.

Table 7.63: Global Moran's I statistics for total counts of outlets and sales at postcode-level, for each financial year between 1 July 2002 and 30 June 2010

	Night2	Weekend Night2
Financial Year	β (p-value)	β (p-value)
2002/03	-0.070 (0.219)	-0.065 (0.241)
2003/04	0.346 (0.000)	0.342 (0.000)
2004/05	0.358 (0.000)	0.360 (0.000)
2005/06	0.273(0.000)	0.283(0.000)
2006/07	0.341 (0.000)	0.342 (0.000)
2007/08	0.303 (0.000)	0.307 (0.000)
2008/09	0.415(0.000)	0.408 (0.000)
2009/10	0.342 (0.000)	0.342 (0.000)

Two Lagrange Multiplier (LM) tests were performed on the residuals of aspatial models to test for omitted spatial lag and spatial errors in the panel data. For models with both Night2 and Weekend Night2 injury as the outcome variable, both LM tests were significant, although the test for omitted spatial error yielded a more significant test statistic. Thus, the null hypothesis of retaining the aspatial panel model could be rejected. Because both tests were significant, robust LM tests were undertaken for each model type, to test for the existence of one type of spatial dependence conditional on the other [386]. The robust

LM test for omitted spatial error remained significant, while the robust LM test for omitted spatial lag was not significant. On the basis of these results, the spatial error model was selected.

Spatial error models were developed in MATLAB using Night2 and Weekend Night2 injuries as the outcome variables. As discussed before, these spatial models were developed for use with continuous outcome variables, not count outcomes, and so the coefficients cannot be compared directly with the aspatial models, nor can incidence rates ratios be computed. The direction and significance of the alcohol availability variables were therefore compared.

Table 7.64 below shows the coefficients for the alcohol availability variables and spatial autocorrelation. Postcode-level socio-demographic variables and zone from the CBD were included in the spatial model, but are not shown in the table. The spatial autocorrelation statistic for both models was highly significant.

Increases in each of the four measures of alcohol availability were associated with increases in both Night2 and Weekend Night2 injuries. The associations were significant for counts of on-premise outlets and sales per off-premise outlet. The direction and significance of the four alcohol availability predictors was the same as in the aspatial model for all sales and outlets in postcodes (Table 7.33).

Table 7.64: Panel spatial error model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, and distance from the CBD, at postcode-level in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
No buffer	β	t	p	β	t	p
Count of on-premise outlets	0.657*	7.270	0.000	0.396*	7.060	0.000
Count of off-premise outlets	1.925*	2.496	0.013	0.485	1.009	0.313
On-premise sales#/outlet	1.746	1.119	0.263	0.535	0.549	0.583
Off-premise sales#/outlet	1.365	1.908	0.056	1.061*	2.371	0.018
Spatial autocorrelation	0.096*	15.090	0.000	0.091*	13.478	0.000

Sales in 10,000 litres * $p<0.05$

Model with counts of outlets and sales per outlet within 1km of the postcode centroid

The residuals of outlets within 1km for the postcode centroid were used to construct a spatial weights matrix which calculated adjacency by using a distance of 6km from postcode centroid (as discussed in 4.7.1). The global Moran's I was calculated for each financial year in the study. As indicated in Table 7.65, Moran's I was not significant for all financial years for both injury outcome variables (with the exception of the residuals of

2009/10 Weekend Night2 model), indicating the absence of spatial autocorrelation in this data. Therefore, no spatial models were developed for the 1km buffer.

Table 7.65: Global Moran's I statistics for counts of outlets and sales within 1km of the postcode centroid, for each financial year between 1 July 2002 and 30 June 2010

	Night2	Weekend Night2
Financial Year	β (p-value)	β (p-value)
2002/03	0.037 (0.243)	0.054 (0.183)
2003/04	0.072 (0.132)	0.093 (0.086)
2004/05	0.065 (0.150)	0.089 (0.093)
2005/06	0.078 (0.119)	0.103 (0.069)
2006/07	0.079 (0.117)	0.100 (0.073)
2007/08	0.075 (0.124)	0.094 (0.085)
2008/09	0.089 (0.094)	0.104 (0.066)
2009/10	0.101 (0.072)	0.117 (0.049)

Model with counts of outlets and sales per outlet within 2km of the postcode centroid

Global Moran's I for outlets and sales within 2km of the postcode centroid are indicated in Table 7.66. The test used a spatial weights matrix where adjacency was determined using sales and outlets within 7km of the centroid (2km buffer plus 5km). Moran's I was significant for all financial years using the residuals from the Weekend Night2 injury models, and for most financial years using the residuals from the Night2 injury model. For the years 2002/03 and 2003/04, Moran's I for the Night2 models approached significance (p=0.073 and p=0.062 respectively). These results indicated that positive spatial autocorrelation was present and spatial models were developed, as indicated below.

Table 7.66: Global Moran's I statistics for counts of outlets and sales within 2km of the postcode centroid, for each financial year between 1 July 2002 and 30 June 2010

	Night2	Weekend Night2
Financial Year	β (p-value)	β (p-value)
2002/03	0.084 (0.073)	0.137 (0.013)
2003/04	0.09 (0.062)	0.144 (0.010)
2004/05	0.119 (0.025)	0.176 (0.002)
2005/06	0.108 (0.038)	0.177 (0.003)
2006/07	0.138 (0.035)	0.193 (0.002)
2007/08	0.116 (0.027)	0.182 (0.002)
2008/09	0.147 (0.016)	0.198 (0.001)
2009/10	0.147 (0.017)	0.201 (0.001)

LM tests were performed, to test for omitted spatial lag and omitted spatial error in panel data, on the residuals of aspatial models for outlets within 2km of the postcode centroid. For both Night2 and Weekend Night2 injuries, both LM tests were significant, although the test for omitted spatial error was more significant. The robust LM test for omitted spatial error remained significant, while the robust LM test for omitted spatial lag was not significant. Therefore the spatial error model was chosen.

Spatial error models were developed for outlets and sales within 2km of the postcode centroid, in MATLAB, using Night2 and Weekend Night2 injuries as the outcome variables. Table 7.67 below displays the coefficients for the alcohol availability data and spatial autocorrelation. Postcode-level socio-demographic variables and zone from the CBD were included in the spatial model, but are not shown in the table. The spatial autocorrelation coefficient for both models was highly significant.

All four measures of alcohol availability were positively associated with both Night2 and Weekend Night2 injuries, but the associations were not significant. The count of on-premise outlets approached significance for the Weekend Night2 injury outcome. The aspatial models for outlets and sales within 2km of the postcode centroid, in Table 7.35, indicated positive and significant associations between counts of on-premise outlets, and sales per on-premise outlet. The spatial model suggests that these associations were inflated in the aspatial models because of spatial dependence which was not accounted for by the predictors.

Table 7.67: Panel spatial error model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status, and distance from the CBD, at postcode-level in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	β	t	p	β	t	p
Count of on-premise outlets	0.208	1.786	0.074	0.136	1.893	0.058
Count of off-premise outlets	0.871	1.207	0.228	0.416	0.936	0.349
On-premise sales#/outlet	0.534	0.622	0.534	0.510	0.957	0.339
Off-premise sales#/outlet	0.054	0.102	0.919	0.236	0.716	0.474
Spatial autocorrelation	0.460*	9.591	0.000	0.388*	7.375	0.000

Sales in 10,000 litres * $p<0.05$

Model with counts of outlets and sales per outlet within 5km of the postcode centroid

Global Moran's I for outlets within 5km of the postcode centroid are indicated in Table 7.68. The test used a spatial weights matrix where adjacency was determined by using sales and outlets within 10km of the centroid (5km buffer plus 5km). Moran's I was significant for all financial years using the residuals from the Night2 and Weekend Night2 injury models. These results indicated that positive spatial autocorrelation was present and spatial models were developed, as discussed below.

Table 7.68: Global Moran's I statistics for counts of outlets and sales within 5km of the postcode centroid, for each financial year between 1 July 2002 and 30 June 2010

	Night2	Weekend Night2
Financial Year	β (p-value)	β (p-value)
2002/03	0.321 (0.000)	0.308 (0.000)
2003/04	0.312 (0.000)	0.298 (0.000)
2004/05	0.303 (0.000)	0.291 (0.000)
2005/06	0.291 (0.000)	0.279 (0.000)
2006/07	0.283 (0.000)	0.274 (0.000)
2007/08	0.28 (0.000)	0.273 (0.000)
2008/09	0.274 (0.000)	0.264 (0.000)
2009/10	0.277 (0.000)	0.270 (0.000)

LM tests were performed to test for omitted spatial lag and omitted spatial error in the panel data, on the residuals of aspatial models for outlets within 5km of the postcode centroid. For both Night2 and Weekend Night2 injury outcomes, both LM tests were significant, although the test for omitted spatial error was more significant. Thus, the null hypothesis of retaining the aspatial panel model could be rejected. The robust LM test for omitted spatial error was significant, while the robust LM test for omitted spatial lag was not significant. Therefore the spatial error model was chosen.

Spatial error models were developed for outlets and sales within 5km of the postcode centroid in MATLAB using Night2 and Weekend Night2 injuries as outcome variables. Table 7.69 below shows the coefficients of the alcohol availability data and spatial autocorrelation. Postcode-level socio-demographic variables and zone from the CBD were included in the spatial model, but are not shown in the table. The spatial autocorrelation coefficient for both models was highly significant.

Increases in all four measures of alcohol availability were positively associated with increase in both Night2 and Weekend Night2 injuries, but the associations with counts of on- and off-premise outlets were not significant. Sales per off-premise outlet were significantly associated with both injury outcomes. Sales per on-premise were strongly significantly associated with Weekend Night2 injuries and approached significance for the Night2 injury outcome. The aspatial models for outlets and sales within 5km of the postcode centroid, in Table 7.36, indicated positive and significant associations between sales per off-premise outlet, and sales per on-premise outlet with Night2 injuries but not Weekend Night2 injuries.

The spatial model thus indicated associations which were qualitatively similar to the aspatial models.

Table 7.69: Panel spatial error model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status, and distance from the CBD, at postcode-level in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	β	t	p	β	t	p
Count of on-premise outlets	0.025	1.121	0.262	0.010	0.761	0.446
Count of off-premise outlets	0.298	1.203	0.229	0.217	1.463	0.143
On-premise sales#/outlet	5.555	1.944	0.052	5.340*	3.097	0.002
Off-premise sales#/outlet	1.785*	2.498	0.012	1.414*	3.258	0.001
Spatial autocorrelation	0.532*	13.147	0.000	0.479*	10.780	0.000

Sales in 10,000 litres * $p<0.05$

7.4 Summary

This chapter presented the results of the final phases of the project, showing the development of the aspatial models, and testing and modelling for spatial dependence in the data. The results showed that associations between measures of alcohol-related injury and alcohol availability differ between on- and off-premise outlets. Some statistical models showed that counts of off-premise outlets are negatively associated with measures of alcohol-related injury, but these associations were not demonstrated in the final spatial models. Counts of on-premise outlets, and sales per off-premise outlets were consistently positively associated with both measures of alcohol-related injury across different time series and geographic units. The spatial models, while not optimal, broadly supported the results of the aspatial models.

8 Summary and Discussion

Chapter Eight provides a summary and discussion of the overall findings of the study. It starts by relating the findings to the hypotheses outlined in 4.2. In 8.2, the strengths and limitations for each phase of the study are discussed. Following this, the possible mechanisms behind the results are discussed in 8.3. The implications for policy and research are outlined in 8.4, and are followed by concluding remarks.

8.1 Summary of findings as they relate to hypotheses

This section explores how the results relate to the hypotheses posited in 4.2. Each hypothesis is discussed in turn.

(a) Night-time hours are peak times for alcohol-related injury presentations at Perth Metropolitan EDs. Injuries occurring during weekend night-time hours are a strong proxy of alcohol-related injury.

This study used a validation method initially proposed by Evans and colleagues using South Australian ED data [164]. The method was based on the findings of a study using international ED data by Young et al.[168]. Although most injuries occurred during the day, Young et al. showed that a higher proportion of night-time and weekend injuries involved alcohol: over 50% of those presenting between midnight and 4:59am and 26% of those presenting over the weekend reported drinking alcohol in the last six hours.

The findings in this study indicated that Perth ED data followed similar trends to both the international and South Australian data: a high proportion of wholly alcohol-related cases presented during the night hours, especially after 10 pm. Further, presentations on weekend nights consisted of even higher proportions of wholly alcohol-related cases than weekday nights.

Both Night2 (midnight to 4:59am) injuries and the combined measure of injuries occurring on weekend nights between midnight and 4:59am (Weekend Night2 injuries) were therefore chosen as appropriate surrogate measures of alcohol-related injury since both are highly sensitive and moderately to highly specific. A highly specific surrogate measure, such as young male weekend night-time injuries, was not selected as it would have provided a much smaller sample (only approximately 4% of the total injuries presenting at EDs in Perth) and would have reduced statistical power in the analysis.

(b) *In a given area, the level of wholesale alcohol purchases is significantly associated with the risk of alcohol-related injury requiring ED attendance. The magnitude of this relationship will vary by licence type and beverage type.*

The unadjusted relationship between wholesale alcohol purchases per alcohol outlet (a proxy for average retail sales of alcohol) and alcohol-related injuries presenting at EDs was strongly significant and positive (an additional 10,000 litres sold was associated with 7% and 4.4% increases in Night2 injury at postcode- and suburb-level respectively).

When controlling for postcode-level socio-demographic factors and distance from the CBD, sales per off-premise outlet, but not sales per on-premise outlet, were significantly associated with alcohol-related injury. The final model, which controlled for counts of on- and off-premise outlets and sales per on-premise outlet, socio-demographic factors, and distance from the CBD, demonstrated that an additional 10,000 litres of alcohol sold per off-premise outlet was associated with a significant rise of 1.9% in Night2 and Weekend Night2 injury at postcode level. The relationship between sales per on-premise outlet and alcohol-related injury varied across the models—in some models it was positive and significant (i.e. in the outer postcodes and in models including outlets within 2km from the postcode centroid), while in most models it was not significant. In summary, the association between off-premise outlets and injury appeared to be mediated by sales; this was less clear for on-premise sales per outlet.

Alcohol sales were further disaggregated into beverage type (low- and high-alcohol beer and wine, ready-to-drink (RTD) and straight spirits). Beverage-specific sales and ED alcohol-related injury presentations were not associated (models not shown), probably because of the large number of variables included in the models (compared to non-beverage-specific models), and resulting loss of statistical power. As a result, this aspect of the hypothesis could not be rejected.

(c) *For a given retail price of alcohol, higher levels of consumption will occur where the average distance travelled from place of residence to obtain alcohol is less.*

The price of alcohol (total price) comprises the real price (the price charged by the outlet) and the convenience cost (costs to access the alcohol, such as distance travelled to access alcohol). The online survey results demonstrated that the majority of drinkers were not prepared to travel far to purchase undiscounted alcohol (6.2.3); approximately 50% of participants usually travelled less than 5km to purchase alcohol at a bottle shop or hotel, suggesting that proximity could drive consumption levels up. Volumes of alcohol sales in the buffer zone up to 5km from the postcode centroid were higher than volumes in the 2km and 1km buffer zones. However, the larger (5km) buffer zone included data from the inner buffer zones: that is, the buffer zones were not mutually exclusive, so distance travelled to an outlet could have been less than 2km (or 1km) for models for the 5km buffer zone. This made it difficult to compare sales levels (as a proxy for consumption levels) at different distances from the postcode centroid, or draw definite conclusions about the influence of convenience cost on consumption levels.

(d) The risk of alcohol-related injury requiring ED attendance will be greater where the average distance from place of residence to alcohol outlets is less.

Because the buffer zones used to approximate distance from place of residence to alcohol outlets were not mutually exclusive, all outlets and their sales in the 1km buffer were included in the 2km and 5km buffer zones. Similarly all outlets and their sales within the 2km buffer zone were included in the 5km buffer zone. Therefore, models using the 2km buffer allowed for a distance from centroid to outlet of 0 to 2km, and models using the 5km buffer allowed for a distance to outlet of 0 to 5km. Despite this, it would be expected that the average distance to outlet would be greater, and more outlets would be included, in the 5km buffer models than in the 2km and 1km buffer models (the exception being in postcodes where there were no additional outlets between the 2km and 5km buffer zones, e.g. larger postcodes which are less densely populated and where outlets are more dispersed). Thus, if the associations between alcohol-related injury and measures of alcohol availability were larger in models using the smallest buffer zone than in models using the largest buffer zone, this hypothesis would be supported. The findings in relation to this hypothesis were mixed, varying by geographic unit of analysis. At postcode level, the hypothesis was not supported: significant associations were shown between alcohol-related injuries and both on- and off-premise sales per outlet where 5km buffer zones were applied, while incidence rate ratios were smaller where 1km buffer zones were applied. The differences between the incidence rate ratios for sales per off-premise outlets for the 1km and 5km buffer zone models were statistically significant[65]. However, at suburb level, the hypothesis was supported: the incidence rate ratios for off-premise sales per outlet occurring within 1km of the geographic centroid of the suburb of residence for injuries were larger in magnitude, but not

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[65] The coefficients for sales per outlets for 1km and 5km buffer zone models at both postcode and suburb level were compared using the ‘test’ command in Stata. The results indicated that the two coefficients for off-premise sales, but not on-premise sales, were significantly different from each other ($p<0.05$) at the postcode level.

significantly different from, incidence rate ratios for off-premise outlets within 5km of the centroid.

Testing of this hypothesis was limited by the use of a proxy for place of residence rather than actual place of residence, and by the use of buffer zones as proxies for distance to outlet. Using the geographic centroid as a proxy for place of residence effectively measures an ‘average’ place of residence in the neighbourhood (postcode or suburb), rather than measuring each individual place of residence. Thus, buffer zones measure an average distance to alcohol for all residents of a particular postcode or suburb, rather than an individual-level distance to alcohol. Distance to outlet is an approximation of ‘convenience cost’. If convenience cost operates at an individual level, the use of the geographic centroid as a proxy for place of residence would have affected the ability of this study to measure the effects of convenience cost.

(e) The strength of the relationship between alcohol-related injury requiring ED attendance and outlets will vary by licence type.

In the final models, individual licence types were aggregated into off-premise outlets (liquor stores) and on-premise outlets (restaurants; hotels and taverns; nightclubs; clubs; and other licence types). Although the count of individual on-premise outlets was similar to the count of liquor stores (for example 333 hotels and taverns, compared to 318 liquor stores), individual on-premise licence types sold relatively smaller amounts of alcohol[66].

Models including counts of licensed outlets, their sales and other predictors revealed differences in the patterns of association between alcohol-related injury and on- versus off-premise outlets, supporting the above hypothesis. At postcode level, counts of on-premise outlets were significantly associated with both Night2 and Weekend Night2 injuries. (This association was weaker at suburb level). At both postcode and suburb level, off-premise sales per outlet were more strongly and significantly associated with both measures of alcohol-related injury. In some postcode-level models, counts of off-premise outlets were negatively associated with alcohol-related injury, while positive but significant associations between sales per on-premise outlets and alcohol-related injury were shown in only the larger buffer zone models.

[66] Restaurants had mean pure alcohol sales of only 498 litres per outlet per year, with club, other on-premise outlets and nightclubs having mean sales of fewer than 2,500 litres per outlet per year.

Given the differences between the associations of alcohol-related injury with on- and off-premise outlets, this hypothesis is supported. However, it appears that additional unexplained factors might account for varying results in associations with sales per on-premise outlets (such as the influence of price at greater average distances from the centroid), and counts of off-premise outlets (such as the varying effects of proximity in different parts of the metropolitan area).

(f) *Alcohol outlet density and sales are independently associated with alcohol-related injuries at EDs according to the type and location of outlets, and these relationships are mediated by the distance from place of residence to outlets.*

This hypothesis was partially supported: in relation to independent associations according to 'type' of outlet, counts of on-premise outlets and sales per off-premise outlets (per postcode) were independently and positively associated with alcohol-related injury. Counts of off-premise outlets were either negatively associated with, or not significantly and positively associated with alcohol-related injury. Sales per on-premise outlet were not consistently significantly associated with alcohol-related injury.

The study demonstrated that associations between alcohol availability variables and injury varied, depending on the location of outlets relative to the CBD. In the inner suburbs (CBD to 7km from the CBD), alcohol-related injury was significantly associated with counts of on-premise outlets, while in the middle suburbs (7km to 15km from the CBD), alcohol-related injury was significantly associated with sales per off-premise outlet. In the outer suburbs (beyond 15km from the CBD), alcohol-related injury was associated with both on-premise counts and sales. These associations were for models using postcode as the primary geographic unit, and suggest that associations with injury in the inner postcodes were mediated more by the amenity effect, while those in the middle postcodes were more proximity-related. In the outer postcodes, significant associations were apparent between on-premise, but not off-premise, outlets and injury. Because of the mixed results across the different sized buffer zones and distance-zones from the CBD, it was not possible to discern a clear pattern pertaining to the location of outlets and the distance travelled to obtain alcohol. Thus, this aspect of the hypothesis cannot be accepted or rejected.

As the radius of each buffer zone functioned as a proxy for 'distance to outlet', the models incorporating the three buffer zones were compared to ascertain whether the associations between alcohol availability measures and alcohol-related injury were mediated by distance from place of residence to outlets. In the models using the 5km buffer zone at postcode level, the effect sizes for sales per outlet and alcohol-related injury were significantly larger, but effect sizes for counts of outlets and alcohol-related injury were significantly smaller than in the 1km and 2km buffer zone models[67]. (In models using the 5km buffer zone, the potential average distance travelled from place of residence to outlet would be higher than for models using the 1km and 2km buffer zones). This trend was evident for both on- and off-premise outlets. Both sales per on- and off-premise outlets within 5km of the postcode centroid were more strongly and significantly associated with alcohol-related injury than sales per outlets within 1km of the centroid. This may have reflected the greater range of outlets in the 5km buffer zone (for example, choices may be influenced by lower prices at individual outlets, leading to larger sales despite greater convenience cost). Conversely, the association between counts of on-premise outlets within 1km of the geographic centroid and alcohol-related injury was larger than the association with alcohol-related injury of on-premise outlets within 2km of the centroid; and this association disappeared in the buffer 5km from the centroid. Similar trends were shown when comparing suburb-level models for outlets within 1km and 5km of the geographic centroid of the suburb. However, because the geographic centroid was used as a proxy for place of residence, the measure of 'distance to outlets' in this study represented an average distance (across the geographic unit) rather than an individual-level distance to outlets. This measure might have masked the true mediating role of 'distance to outlets' in the association between availability and injury. Furthermore, the use of all outlets up to 5km in the largest buffer zone models meant that outlets associated with injury were not necessarily located in the distance band 2 to 5km from the centroid. (For example, an outlet associated with an assault might be located only 1.2km from the postcode centroid but would be included in models for the 5km buffer zone.) This limits the interpretation of the buffer zone models. As a result, this part of the hypothesis cannot be rejected using the current measure of 'distance to outlets'.

8.2 Strengths and limitations of the study

8.2.1 Study design and methods

This longitudinal study is unique in that it incorporated data on counts of outlets, sales and trading hours. Previous longitudinal research investigating the association between alcohol availability and alcohol-related harms has used only counts of alcohol outlets or

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[67] The coefficients for sales per off-premise outlets and counts of on-premise outlets for the 1km and 2km buffer zone models were compared to the 5km buffer zone models using the 'test' command in Stata. The results indicated that the coefficients were significantly different from each other ($p<0.05$).

measures of alcohol outlet density (e.g. [16, 19, 341]). Previous studies that have included both counts of outlets and sales have been cross-sectional in design, which limits the power of the study and prevents causal inference because temporality cannot be demonstrated. No previous research has incorporated all three measures of alcohol availability. Because alcohol sales data are not available in many other Australian states and countries, this study is undeniably significant in the alcohol availability field.

The study used panel data, with each observation having both a spatial (postcode or suburb) and temporal (financial year) component, enabling methods of analysis with more statistical power. Time series analyses would have had little power because eight years of data were available, and cross-sectional analysis would not have taken into account changes over time. The data used were objective, so not subject to recall or social desirability bias, as is the case in alcohol studies using survey data on alcohol availability and consumption levels.

A strength of this study was the combined use of the traditional statistical methods of epidemiology with the incorporation of statistical methods from the spatial sciences. Although the use of several methodologies increases the number of assumptions made, in this study the different methods ensured that, at each stage, the results for individual models were confirmed using different methods and software. For example, GIS was used to link place of residence to alcohol availability by distance, and models were then developed using traditional statistical methods. However, the total postcode (and suburb) models did not involve mapping geographical relationships. These models acted as a ‘check’ for the buffer zone models. Similarly, the non-spatial (traditional) model results were developed in both Stata (a traditional statistical package) and MATLAB (a technical computing language and program), and compared. The spatial model results (from MATLAB) were consistent with non-spatial models (from Stata). By mapping the link between place of residence and alcohol availability, then using traditional statistical methods to build regression models, and finally accounting for spatial dependence within the data, the methods of analysis crossed several disciplines.

The associations demonstrated between alcohol availability and alcohol-related injury in this study are consistent with previous alcohol availability studies (e.g. [22, 29, 218]). The effect sizes were not large for all models controlling for the known confounding factors, and the associations may have been influenced by unknown (and uncontrolled-for) confounding factors, but the consistency with previous research (e.g. [22]) suggests that the findings may be considered reliable.

A further strength of the final models was the inclusion of variables controlling for postcode- (and suburb-) level socio-economic status (SEIFA category) and demographics (including age, gender, Indigenous status and total population). The study area was the Perth Metropolitan Area, excluding smaller cities and regional WA. This ensured that the area was relatively homogeneous. The models included a categorical variable controlling for distance from the Perth CBD, based on classifications used by Luk and colleagues [435]. This variable accounted for differences in road structure and travel patterns across the CBD, by classifying areas according to their distance from the CBD and distance between controlled traffic signals[68]. These zones within the Perth CBD effectively functioned as 'clusters' of postcodes or suburbs, with similar traffic and travel patterns, and accounted for any spatial heterogeneity within the metropolitan area.

Models were developed at both postcode and suburb level. The suburb models were hampered by data quality issues. For example, the suburb definitions used in the Emergency Department Information System (EDIS) changed across the years of the study, and many suburbs contained either no injuries or no alcohol outlets for some or all years included in the study. However, the development of models for the two geographic units (postcodes and suburbs) strengthened the study in three ways. Firstly, it allowed examination of how associations between alcohol availability and alcohol-related injury differed between larger (postcode) and smaller (suburb) geographic units. Secondly, the suburb models represented a sensitivity analysis, confirming the associations between alcohol availability and injury found at postcode level. Thirdly, the problem of modifiable areal unit problem (MAUP) was effectively controlled for by using two different administrative units. MAUP potentially affects analyses involving administration boundaries such as postcodes, occurring when *"relationships between geographically continuous variables change with the imposition of arbitrary artificial boundaries"* [288]. In the Perth Metropolitan Area, suburbs may cross postcode boundaries, and postcodes can consist of one to four suburbs, so the development of models at both levels ensured MAUP was not leading to spurious associations. The use of models with buffer zones (not involving administrative boundaries) ensured that MAUP did not impact on these models.

Models were also developed that classified outlets according to whether or not they had ETPs allowing extended trading hours. Because of the relatively small number of outlets

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[68] Models were also created where areas were classified simply by median distance between controlled traffic signals. The models showed similar but often weaker or inconsistent associations between alcohol availability measures and alcohol-related injury.

with ETPs, associations with alcohol-related injury had wide confidence intervals. However, the models were consistent with the results demonstrated by Chikritzhs [30], reiterating that on-premise outlets with extended trading hours had higher sales per outlet and increased risk of injury compared to outlets without extended trading hours.

The use of the Stata statistical package to build the models using negative binomial regression with random effects was complemented by the use of MATLAB to build panel models accounting for spatial patterns in the model residuals. One of the limitations of the study was the unavailability of MATLAB user-written code for frequentist spatial models for count-dependent variables (which follow a negative binomial or Poisson distribution). The panel models with functions written in MATLAB (and similar emerging user-written code for Stata) were for (normally distributed) continuous dependent variables only. Bayesian spatial models for panel count data could have been used in this study. However, the assumptions underpinning frequentist and Bayesian models differ widely and so the frequentist non-spatial models and the Bayesian spatial models would not have been directly comparable. It is possible that within the next few years, frequentist spatial models for count data will be better developed and available through user-written routines in Stata, MATLAB and other software. However, at the time this thesis was written, these routines were not available. As a result of these limitations, developing the spatial models in MATLAB was effectively a sensitivity analysis; the coefficients could not be directly compared to the non-spatial models but variables were examined for similar direction and significance levels.

8.2.2 Use of EDIS data

The ED injury data were extracted from the EDIS for the years 2002—2010. The study was strengthened by the inclusion of all cases reported via the EDIS, rather than a sample of cases, as used in many previous ED studies investigating alcohol-related injury [111, 455], which improved the power of the analyses. The study was further strengthened by the use of eight years of data, rather than using cross-sectional data.

The ED data were collected by clinicians. The nature of an ED is that presentations may be urgent and life-threatening; the primary concern in any ED is clearly the care of patients, not the accurate collection of data for research purposes. This factor could have led to inaccurate data collection and missing fields in the EDIS data. External cause codes were almost entirely absent from the extraction, so it was not possible to identify whether injuries were the result of road crashes, assaults (outside or within the home), suicide or other causes. Furthermore, it could not be ascertained whether injuries were intentional or unintentional. In a large proportion of cases, demographic details such as marital status were missing, and a high proportion of ED presentations had recorded 'unknown' in relation to Indigenous status. Because the latter variable was regarded as an important predictor, it was included, despite potential issues with the quality of data recording.

Although most Perth EDs began electronic data recording using the EDIS in 2002, a small number of hospitals started in 2004 and 2005 (Joondalup Health Campus/JHC and King Edward Memorial Hospital for Women) while the one private ED (St John of God Murdoch), did not provide EDIS reports to the WA Health Department. As a result, the number of ED-presenting alcohol-related injuries was undercounted, particularly from July 2002 to July 2004. This primarily affected postcodes and suburbs beyond 15km north of the CBD (the catchment area of the JHC). To explore the effect of this missing data, the models using the longer time series (2002/03 to 2009/10) and the shorter time series (2004/5 to 2009/10) were compared. Although there were differences between the models using the two time periods, these related to the size of the association and, in some cases, the significance of associations. The direction of the associations did not change. As a result, the longer time series (2002/03 to 2004/05), which had much greater statistical power because it contained 25% more panels than the shorter time series, was chosen as the primary time series.

King Edward Hospital is a maternal and gynaecological hospital hence very few cases presenting at its ED would involve alcohol-related injury. St John of God Murdoch ED represented a small proportion of ED presentations in the city. These missing injury data would cause a minor attenuation of associations between measures of alcohol availability and alcohol-related injury, rather than overestimating associations.

8.2.3 Surrogate measures of alcohol-related injury

Blood alcohol testing is not routinely carried out at Perth EDs. The results of such testing are therefore not available in the EDIS. Moreover, it would be expensive and time-consuming to collect self-reported alcohol consumption in the six hours prior to injury, and would not be practical for a study of this size. However, surrogate measures offer a viable alternative means of identifying alcohol-related injuries and have been widely used in research [164, 168, 188].

Case by case, surrogate measures cannot typically provide accurate estimates of the number of alcohol-related injuries, but they are suitable, and often preferable, for examining trends over time [163]. Given that this study used longitudinal data, precise identification of individual cases was of less concern than if the study had been cross-sectional in design, because the design allowed for demonstration of trends over time and the analysis had increased statistical power because of multiple years of data.

The surrogate measure was validated for the study area using methods from well-designed international and Australian studies. It is important that any surrogate measure be validated for the population on which it is being used [147, 172] because of varying demographic patterns, cultural attitudes to alcohol and patterns of alcohol use.

When choosing a surrogate measure of alcohol-related injury for this study, a degree of specificity was sacrificed to increase the number of injury cases included, so that the study had sufficient statistical power.

8.2.4 Boundary changes

Over the period of eight years, administrative boundaries (e.g. of LGAs, postcodes and suburbs) would have changed. As data were only available for boundary changes to LGAs, and not for changes to postcodes or suburbs, accounting for these latter changes in the analyses was difficult. From the data on changes to LGA boundaries, it was established that the changes were probably on the borders of postcodes and represented a very small proportion of the total area, resulting in a negligible effect on the models.

A further limitation was that the ABS administrative area 'postal areas' was used for socio-demographic data, electronic maps and consequently the allocation of alcohol availability measures to geographic units. Further, the Australia Post area 'postcode' was used for identifying the place of residence of ED injury presentations, as this was recorded in the EDIS. Postal areas are *"an ABS approximation of Australia Post postcodes"* [456]. Therefore, geographically, postal areas and postcodes are similar, but not identical. It was not possible to control for these differences in any way, and attempts to source Australia Post postcode maps failed. However, the differences are likely to be very small and unlikely to affect the results substantially. In fact, it is usual practice in Australian studies to assume that postcode and postal area boundaries are interchangeable, for example [15, 341, 355].

8.2.5 The geographic centroid of a postcode as a proxy for place of residence

A major assumption made in this study was that the geographic centroid of the postcode or suburb represented the place of residence. As only the suburb and postcode of residence of injury presentations were provided by the Data Linkage Branch, a proxy for place of residence was required so that the data could be analysed in relation to alcohol availability data. There were two possible proxies: a geographic or geometric centroid, and a population-weighted centroid of the geographic area. While population-weighted centroids have been used in outlet density studies in New Zealand [280, 281], the geographic unit of analysis was meshblocks, a much smaller administrative area than postcodes or suburbs, and the study area was outside the capital city. The geographic centroid for each administrative unit could be easily calculated in ArcGIS using the ABS shapefiles, while data on population-weighted centroids were not readily available for the Perth Metropolitan Area. As a result, the geographic centroid was used in this study.

However, it was unknown how accurately the centroid (population-weighted or geographic) represented place of residence. Only one alcohol outlet density study has compared the use of the geographic centroid as against individual residential addresses when picking a proxy for place of residence [281]. The authors found *"no discernible difference"* between the two measures of place of residence.

The geographic centroid may have been a more accurate measure of place of residence in a smaller administrative area such as a suburb, than in a larger area such as a postcode, or vice versa. The former possibility was supported by the stronger associations demonstrated in suburb models including outlets within 1km from the centroid, compared to the equivalent postcode models. However, the results for all the models were similar, but weaker for the suburb models including outlets at larger distances from the centroid. Further, using a geographic centroid as a postcode-average 'place of residence', and then creating models using a variety of buffer zones around this might 'average out' any associations between alcohol-related injury and measures of alcohol availability. Models using larger buffer zones of up to 10km and up to 20km from the geographic centroid demonstrated little or no association between alcohol-related injury and measures of alcohol availability (data not shown). However, models using buffer zones of up to 1km, up to 2km and up to 5km revealed significant associations with alcohol-related injury, particularly with counts of on-premise outlets and sales per off-premise outlet. Nevertheless, it is unknown whether these results actually reflect an association with the place of residence of alcohol-related injury cases or if the geographic centroid acted as a proxy measure of something else.

The association between counts of on-premise outlets and alcohol-related injury was significantly larger in models including outlets within 1km of the centroid. Conversely, the associations demonstrated between sales per on- and off-premise outlets were significantly larger in models using outlet data for the 5km buffer zone than for smaller buffer zones. This suggested that different mechanisms may have facilitated the association between sales per outlet and alcohol-related injury, and between counts of outlets and alcohol-related injury;

and suggested that the centroid of the administrative unit may have functioned differently in relation to alcohol sales and counts of outlets. For instance, the geographic centroid is a central point in each postcode, easily accessible through transport routes, with clustering of shops and leisure activities, and so it might function as a small-scale commercial centre or even an entertainment district within the postcode. The implications of this possible role of the geographic centroid will be explored further in 8.3.1.

8.2.6 Unmeasurable and unknown factors

Some potential predictors and confounding factors were either impossible to measure or to control for. Geographical structures such as rivers and lakes could have affected access to alcohol. Because the majority of people travel by car to purchase alcohol (nearly 88%—Table 6.5), using road networks (rather than straight-line distance) from the place of residence might have 'controlled for' these geographical features. This was not an option in this study however, as the centroids of some postcodes and suburbs were not located on a road, making it impossible to use road network distance.

The online survey suggested that the place of work might play a role in the choice of where to purchase alcohol. Data on the place of work of injured people were not recorded in the EDIS, so this factor could not be included in the models.

Economic availability includes real price: that is, the dollars and cents paid by consumers to the alcohol outlet or premise to purchase alcohol. The price for the same product varies from outlet to outlet, because of factors such as the type of outlet, the volumes sold per outlet and the use of alcohol as a loss leader (for example in supermarkets). Although the quantity of alcohol purchased was known, the influence of price on purchase volumes could not be established with the data available.

Other unknown factors could have played a role in the association between alcohol availability and injury, which could have affected the results. These could have included regulation changes in individual councils within the metropolitan area, management practices and server training at individual outlets, and levels of police enforcement of the 'Responsible Beverage Service' (RBS)[69] policy, minimum legal drinking age legislation and BAC limits on drivers. These factors would variously strengthen or attenuate associations between alcohol availability and alcohol-related injury.

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[69] RBS includes: avoiding drink promotions that encourage intoxication, refusing to serve alcohol to obviously intoxicated customers and attempting to prevent intoxicated customers from driving after leaving an outlet by providing safe rides or encouraging the use of designated drivers [457].

8.2.7 Generalisability

The study used data solely from the Perth Metropolitan Area, so the findings are specifically applicable to this area. The associations between alcohol availability and alcohol-related injury are likely to differ in magnitude across regional WA, given the vast size of the state, the varying population densities, differing lifestyles and travel patterns across the state. It is expected that, while the magnitude might vary, the association between alcohol availability and alcohol-related injury would persist when population size and population density were controlled for [29].

The choice of the buffer zones was based on responses to an online survey administered to a sample of participants from the capital cities in Australia (excluding Darwin). The differing physical and population structures of the cities suggested that the alcohol availability models from Perth would not be directly transferable. However, the general trends are likely to be similar for total postcode and buffer zone models in the other major capital cities in Australia. The size of the buffer zones would not be applicable in regional areas of WA or other parts of Australia.

8.3 Discussion

This thesis demonstrated the validation and use of a surrogate measure of alcohol-related injury at EDs, explored the distances that Australians living in metropolitan areas were prepared to travel to purchase alcohol, and showed the independent associations of counts of outlets, sales per outlets and trading hours, with risk of presentation at an ED with an alcohol-related injury.

8.3.1 Surrogate measures of alcohol-related injury presentation at an ED

Because there was no data on BAC or self-reported alcohol consumption, a surrogate or proxy measure for alcohol-related injury was used in this study. An advantage of using a proxy measure for ED alcohol-related injury over direct measurement of BAC, self-reported consumption or an alcohol-related road crash surrogate is that such a proxy measure enables the inclusion of injury cases that have not themselves consumed alcohol, but have been injured as a result of the actions of someone who has consumed alcohol. For example, a passenger in a car with a driver who has been drinking, or a victim of an assault by a drinker, may not have consumed alcohol and would not have been reported using other methods of measuring the involvement of alcohol in injuries.

The validation process followed in Phase one of this study used methods described and used on data from South Australian EDs by Evans and colleagues [164]. Both studies used proportions of alcohol-involved injury cases derived by Young et al. using data from multiple international EDs (including a Perth ED) [168, 371]. The study by Evans and colleagues chose 'Night2 injuries' (injuries between midnight and 4:49am) as the 'preferred surrogate' of alcohol-related injuries, and this was chosen as one of the two surrogate measures for the current study. Previous Australian research has confirmed that a high proportion of street incidents (such as assault) over this time period are alcohol-related [6], while a high proportion of assaults occurring at or near licensed premises in the early morning hours involve alcohol [169, 170]. Further, extensive international research has concluded that night-time crashes (involving a single vehicle, fatal or serious injury) are a valid surrogate for alcohol-related crashes (e.g. [172, 174, 177, 178, 181, 182].

A second surrogate, Weekend Night2 injuries, was chosen in this study. Although the previous two studies explored the use of weekend injuries as a surrogate of alcohol-related injury, the authors used a different definition of 'weekend' (Friday, Saturday and Sunday) from the definition used in this study (Friday evening to Monday morning). Evans and colleagues considered the latter to be a *"more robust measure"* of weekend alcohol-related injuries (p. 90 [164]). The definition of 'weekend' used in this study was more consistent with probable weekend alcohol presentations, because presentations early on a Monday morning are likely to be related to Sunday night drinking, while presentations early on a Friday morning (included by Young et al. [168]) would be associated with drinking on a Thursday evening. Despite their reservations about Young and colleagues' definition of 'weekend', Evans and et al. used it to explore a combined Weekend Night2 surrogate measure.

Unfortunately, Young et al. did not use a combined weekend night-time surrogate and so the proportion of injury cases involving alcohol during this time period was not available. However, this combined surrogate is consistent with previous research, which has shown that higher proportions of alcohol-related incidents occur over weekends, including assaults [147, 170] and ED injury presentations[173, 186, 187]. Further research has demonstrated that even higher proportions of alcohol-related incidents occur over weekend nights: assaults on Sunday mornings in inner Sydney [170], weekend night-time crashes in Australia [180, 183], and alcohol-related ED presentations internationally [24, 140, 458].

8.3.2 The association between alcohol availability and alcohol-related injury

While a large body of literature has demonstrated that increased alcohol availability is associated with various alcohol-related harms, there has been a lack of consistency in the associations between outlet types and different alcohol-related harms. Previous research has focused primarily on outlet density as a measure of availability, with all outlets essentially being treated as the same, in terms of size and sales. Few studies have explored the associations between sales and alcohol-related harm (e.g. [365]). Even fewer studies have explored the independent associations of sales and outlet density with harm [22, 23, 372]. By using several measures of availability (outlet count, sales and trading hours), this study provided a more complete measure of overall 'availability'. This enabled exploration of the differences between on- and off-premise alcohol sales, and whether distance to outlets mediated the associations between measures of availability and alcohol-related injury.

The final study hypothesis is that "*alcohol outlet density and sales are independently associated with alcohol-related injuries at EDs according to the type and location of outlets, and these relationships are mediated by the distance to outlets*". This thesis has demonstrated overall that higher numbers of on-premise outlets and greater sales per off-premise outlet were independently associated with higher risk of presentation at an ED with an alcohol-related injury.

This hypothesis and other hypotheses were supported by availability theory and routine activities theory. In their expanded and updated version of availability theory, Stockwell and Gruenewald proposed four extended propositions of availability. The second stated that *"Greater availability of alcohol in a society will directly affect alcohol-related harm when such changes affect the distribution of 'routine drinking activities'; behaviours drinkers engage in when consuming alcohol (e.g. drinking at bars vs. at home; drinking socially vs. alone)."* (p. 217 [191]).

'Greater availability' in this study was represented by both higher sales per outlet (which may be mediated by price and accessibility of the outlet) and greater numbers of outlets per geographic unit (through the granting of more liquor licences per area). Liang and Chikritzhs propose that the influence of an outlet on harm is mediated by its function—broadly, whether it sells alcohol for off- or on-premise consumption [84, 340]. Thus, the patterns of 'routine drinking activities' will vary, depending on the type of outlet. In the context of the findings of this study, this suggests that the behaviour of patrons drinking at on-premise outlets may differ depending on both the count and clustering of outlets in a geographic area. Conversely, higher sales per outlet may represent greater economic availability (a lowered 'real price' through changes to the 'retail price') leading to changed patterns of consumption (as suggested by the first proposition of availability [191]), and thus to increased alcohol-related harms.

Underlying mechanisms of change: off-premise outlets

The results of this study provided evidence of the independent association between sales per off-premise outlet and alcohol-related injury. Although counts of off-premise outlets were significantly positively associated with alcohol-related injury in the models containing only alcohol availability variables, this association disappeared when population size was controlled for. Some statistical models demonstrated a negative association between counts of off-premise outlets and injury.

These mixed results suggested that the association between availability at off-premise outlets and alcohol-related injury was mediated primarily by sales rather than by number of outlets. Individual characteristics of off-premise outlets such as total floor area, fridge space, parking spaces, type and amount of price discounting, range of drinks and the nature and ambience of the outlet (warehouse, independent or boutique) might have more impact on buying behaviour[70] and risk of alcohol-related injury than the absolute number of outlets.

Volume of alcohol sales is commonly used as a proxy for consumption levels when calculating per capita consumption levels at population level (e.g. [37]. Stockwell and Gruenewald propose that *"Greater availability of alcohol in a society will increase the average consumption of its population when such changes reduce the 'full price' of alcohol, i.e. the real price of beverages at retail markets plus the convenience cost of obtaining them.'* (p. 217 [191]). This suggests that, controlling for higher counts of off-premise outlets, the increase in sales at off-premise outlets (and consumption of this alcohol) may be mediated by changes in either or both the 'real price' (retail price) and 'convenience cost'(ease of acquiring alcohol, e.g. through proximity to outlets). Changes in 'convenience cost' will be discussed further below.

Lower retail prices have been shown to be associated with increased consumption levels [219] and alcohol-related morbidity and mortality [233]. The price of alcohol may be reduced in several ways: prices may drop due to increased competition from nearby outlets,

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[70] These factors were named by participants in the online survey as influencing their purchasing decisions.

or because supermarket outlets use alcohol as a 'loss leader' (where it is sold at below cost price to encourage shoppers into the store to purchase more profitable goods) [459]. Prices may also be lowered through short-term promotions. Discounting of alcohol at off-premise outlets frequently involves 'rewarding' the consumer with lower prices for purchasing multiple items (e.g. 20% off if four or more bottles of wine are purchased), or incentivising purchases of larger-volume packs of alcohol (e.g. a carton of 24 beers may cost less than three individual six-packs of beer) [459]. The patterns of discounting may change 'routine purchasing behaviours' by encouraging sales of higher volumes of alcohol. This results in the consumption of higher levels of alcohol—through more frequent drinking or drinking of larger volumes of alcohol per occasion. These represent changes to 'routine drinking activities' which result in increased risk of alcohol-related harm.

Previous research has showed varying associations between off-premise outlet density and different alcohol-related harms: no significant positive associations in some studies (e.g. [316]), significant positive associations in other studies (e.g.[209, 241, 279, 332]) and negative associations in others (e.g. [26]). These inconsistent results may be a result of off-premise density being a weak (not robust) proxy for alcohol sales [22].

Furthermore, off-premise outlets may interact differently with harms such as domestic violence, assault and suicide. Higher off-premise sales per outlet expose family members (in places of residence) and friends (at parties) to higher risk of injury through increased consumption levels and increased potential for intoxication. In homes, there is an absence of the 'guardians' that are normally present at on-premise outlets (such as bouncers at hotels and nightclubs, and RBS practices by staff serving drinks at all on-premise outlets). According to routine activities theory [203], the absence of a guardian represents an opportunity for alcohol-related violence to be perpetrated by an intoxicated person ('motivated offender') in the home. At private parties, formal 'guardians' are rarely present to protect potential victims from violent incidents. The opportunities for alcohol-related assault further increase in the presence of other intoxicated (and potentially aggressive) party-goers.

Likewise, without a restraining influence, people may choose to drive while intoxicated. Moreover, higher consumption results in higher BACs, exposing fellow road-users to greater risk when travelling home from a private venue [460]. However, previous research has produced conflicting results on the association between alcohol availability and road crashes. McCarthy demonstrated that higher off-premise density was associated with fewer alcohol-related crashes [297], while Treno and colleagues (in a longitudinal study) showed that off-premise outlet density was positively associated with road crashes. Cameron and colleagues [302] showed that an additional off-premise licence at suburb level was associated with 10 further road crashes. The inconsistent results in these studies may be accounted for by the relative influence of two factors: high off-premise outlet density resulting in outlets being relatively accessible to places of residence, leading to higher consumption levels; and low density of outlets leading to longer travel times to and from outlets, therefore leading to higher exposure to the road [302].

In this study, some models demonstrated negative associations between counts of off-premise outlets and alcohol-related injury (when sales were controlled for), particularly in the outer postcodes. This may be related to the mix of alcohol-related injuries (for example, more road crashes compared to assaults in some areas), which may lead to a negative association between the count of outlets and alcohol-related injuries, because reduced exposure to the road.

There are increasing numbers of liquor superstores, and fewer boutique-style outlets. It is hypothesised that the association between superstores and harms is not necessarily through the larger sales at these stores, but through the manner in which they are used by consumers: purchases may be largely be for large parties or for heavy drinkers who drink alone, than for moderate consumption. These purchases may be for the purposes of drinking to intoxication, rather than moderately, thus increasing risk of alcohol-related harm [89, 98]. Previous research using ED data from a Perth ED has shown that risk of alcohol-related ED presentation is higher among those who drank alone or when more than two drink together [142].

Using a cross-sectional design, Liang and Chikritzhs [22] demonstrated that sales per off-premise outlet were associated with the number of assaults at on-premise outlets in WA. The authors postulate that this might take place partly as a result of the practice of 'pre-loading': consuming alcohol prior to attending an on-premise outlet, probably because of the lower price per standard drink at off-premise outlets. This mechanism might partly explain the association between off-premise sales and alcohol-related injury in this study, as alcohol-related injuries were defined as injuries occurring during night-time hours—the hours during which attendance at on-premise outlets such as nightclubs, hotels and restaurants is highest [240]. However, as data on place of injury (such as on-premise outlets, at private parties or in the home) were not recorded in the EDIS, this could not be demonstrated in this thesis.

On-premise outlets

The results of this study support the hypothesis that counts of on-premise outlets are independently associated with risk of alcohol-related injury, particularly in the postcodes closer to the CBD, which include Northbridge, Leederville and Subiaco, areas that contain large clusters of on-premise outlets such as nightclubs and restaurants [461]. These results concur with the findings of Liang and Chikritzhs in one of the few cross-sectional studies using both counts and sales per outlet, conducted in the state of WA [22]. However, neither the study by Liang and Chikritzhs [22] nor the current study demonstrated an association between sales per on-premise outlet and alcohol-related injury, except in the regression models which included only postcodes beyond 15km from the CBD.

Stockwell and Gruenewald proposed that alcohol-related harms may occur when increased availability changes the behaviours people engage in while drinking (‘routine drinking behaviours’) [191]. Research by Grubesic and Pridemore suggests that assaults tend to occur around clusters of outlets, and that denser clusters of outlets are associated with higher rates of assault [315]. Livingston, Chikritzhs and Room note that when outlet clusters reach a certain threshold, an ‘entertainment district’ results, with outlets behaving as ‘attractors of violence’ [218]. Clustering leads to interaction between people from different outlets, as patrons move between outlets through the evening, representing a change in ‘routine drinking behaviours’. The interaction among groups of intoxicated patrons around an outlet cluster represents greater potential for violence than that which emanates from an equal number of isolated individual outlets. As Chikritzhs describes it: *“By virtue of their collective appeal, premises which are ‘bunched’ together may apply a multiplicative pressure on violence and disorder as they draw large numbers of potential perpetrators and victims into close contact with one another”* (p. 317 [54]). Thus the ‘guardians’ (bar staff, bouncers and management) provided by individual outlets may be insufficient to ‘protect’ potential victims from intoxicated (‘motivated’) offenders.

Livingston and colleagues describe the effect of outlets on the surrounding areas as a negative amenity effect, defined as *“the negative effects (violence, street disturbances, etc) of licensed premises on the neighbourhoods in which they operate (and possibly adjacent neighbourhoods)”* (p. 561 [218]). The need for ‘guardians’ in the form of police presence in the areas surrounding outlets increases as clusters of outlets form ‘entertainment districts’. Insufficient levels of policing increase the risk of both assault and road crashes. In the latter case, visible policing (including random breath testing) and disincentives to drink and drive (for example, double demerit points on drivers’ licences over holiday weekends, which are associated with heavy drinking) act as guardians against drink driving and, consequently, road crashes. Clustered outlets are, by definition, close together so the distance to an outlet-cluster may be larger than would be predicted by the absolute count of number of outlets. Longer driving distance equates to greater exposure to risk of an alcohol-related road crash.

Young males constitute a sub-population group that is disproportionately represented in alcohol-related incidents, including violence [147] and road crashes [171]. Young males are more likely to present at EDs with positive BACs [146] and this demographic group has been considered a highly sensitive and specific surrogate measure of alcohol-related injury in previous surrogate measure research [164, 168], and in Phase one of this study. A high proportion of male and female Australians aged 20—29 years consume alcohol at licensed premises (63% drank at licensed premises compared to 43% of all ages surveyed [451]). Members of this age-group are attracted to entertainment districts and indulge in risky drinking behaviour [451], which places them at greater risk of alcohol-related injury.

The increased competition caused by bunching of outlets in an area may discourage outlets from implementing RBS practices. Australian research has indicated that the vast majority of infringement notices are issued to patrons, with less than 20 per cent of infringement notices served to licensees because of the difficulties that police encounter *"in establishing guilt, prosecuting breaches, and the trivial nature of maximum fines imposed—especially in relation to serving intoxicated patrons"* (p. 321 [54]). Because RBS is not well-enforced, staff may continue to serve obviously intoxicated patrons in order to retain business in a competitive environment.

Moreover, increased competition may lead to outlets trying to distinguish themselves from competing outlets nearby by using price discounting. Discounting may take the form of 'happy hours', where patrons are able to purchase alcoholic beverages for lower prices or 'buy one, get one free' for a limited time, thereby dropping the retail price of alcohol. This has the dual effect of increasing overall consumption, and encouraging the consumption of alcohol in a short space of time, which predisposes drinkers to rapid intoxication.

Because this study did not disaggregate on-premise outlets into hotels and taverns, nightclubs and restaurants, and injuries by external cause, varying associations between outlet types and harms could not be demonstrated. Previous literature has shown associations between bar (hotel or tavern) density and assault [19, 331], intimate partner violence [26] and pedestrian injuries [293], while both restaurant density[331] and total on-premise density [297] have been positively associated with traffic crashes. The different patterns of drinking and functions of outlet types may explain these differences. For example, as stated by participants in the pilot study conducted during Phase two of the project, restaurants are chosen because of the nature and price of the meal provided rather than the price and availability of alcohol. Conversely, the choice of nightclub is more influenced by factors relating to alcohol (e.g. price offers and choice of beverages). The nature of the social interactions and discounting available at different outlet types may lead to associations with different alcohol-related harms.

The mediating effect of distance to alcohol outlets

This study aimed to explore the mediating effect of distance to outlets on the association between alcohol availability and alcohol-related injury. Because the street address of injury cases was not available, the geographic centroid of the postcode (or suburb) was used as a proxy for place of residence, and three buffer zones were created around the centroid. Outlets were placed in buffer zones according to the straight-line distance from the centroid to each outlet. The radius of each buffer zone was a proxy for 'distance to outlet'. Straight-line distance is likely to represent a shorter distance than if road network distance had been used to categorise outlets.

The adequacy of the geographic centroid as a proxy for place of residence was difficult to validate as the only previous study which compared using the geographic centroid as 'place of residence' to using the actual place of residence found no significant difference between the models using the different methods [281].

The geographic centroid of the postcode was effectively an average (or 'neighbourhood') measure of place of residence in the postcode, and therefore the distance from centroid to outlet represented a postcode-level mean distance to outlet.

Halonen and colleagues have shown that decreasing distance from the individual place of residence to the nearest bar was associated with an increase in risky drinking and vice versa [462]. Conversely, Day and colleagues [318] demonstrated that the association between on-premise outlet access and violence weakened as the median distance (from the population-weighted centroid) to the nearest outlet increased (from between 0.9 and 1.3km in the most violent area to between 3.9 and 4.3km in the least violent areas). Scribner and colleagues [349] demonstrated that outlet density affected alcohol consumption via a structural effect: it affected everyone in a particular neighbourhood, and was not an individual-level effect. These findings suggest that levels of consumption may be more closely related to mean distance to alcohol outlets for all residents in a neighbourhood than to individual distances to outlets for each resident. Using the average distance from the geographic centroid of ABS collection districts[71] to the five closest alcohol outlets, Donnelly and Poynton demonstrated that NSW residents living in collection districts with greater average distances to the nearest outlets were at lower risk of property damage and neighbourhood problems with drunkenness [80].

Literature searches did not uncover any further research that demonstrated the difference between using individual versus mean distance to outlets as the mediator in the association between availability and harm. If the association between alcohol availability and alcohol-related harm is mediated by a mean distance to outlets, then using the geographic centroid as 'place of residence' is an appropriate measure of 'distance to outlets'. However, if individual distance to outlets mediates this association, then using the centroid as a proxy would be a less effective measure and less likely to reveal the effect of distance on the association between availability and alcohol-related injury.

Furthermore, residents are exposed to multiple outlets, each of which potentially exposes the consumer to increased risk of alcohol-related injury. Some studies have calculated distance to the closest outlet (e.g. [349] [281] [291]) while others have calculated distance to several closest outlets (e.g. [80]). Calculating the distance to the closest outlet ignores the effect of other nearby outlets which may have relatively greater impact on harm (e.g. by virtue of cheaper alcohol prices or regular discounts and promotions), and also ignores the possible multiplicative effect of outlets bunched together.

This study found that counts of on-premise outlets were more strongly associated with alcohol-related injury in the buffer zones closer to the geographic centroid, while sales per off-premise outlet were more strongly associated with alcohol-related injury in the larger buffer zones. Similarly to Day [318] and Halonen [462], Truong and Sturm have also shown that counts of on-premise outlets were significantly associated with problem drinking, and that this association weakened as the distance from place of residence to outlet increased [283]. In an Australian study, Wilkinson and Livingston specifically studied 'amenity problems' relating to alcohol use[72]; the authors showed that greater distance from an on-

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[71] Collection Districts are the second smallest geographic unit of analysis used by the ABS, the smallest being meshblocks. They consist of approximately 225 dwellings [463].

[72] The measures of negative amenity used in this study were the number of times in the last 12 months that the respondent had *"been kept awake at night or disturbed ; felt unsafe in any other public place…; avoided drunk people or places where drinkers are known to hang out; been annoyed by people vomiting, urinating or littering when they have been drinking; and have your house, car or property damaged"* (p. 3 [291])

premise outlet was associated with decreased experience of disrupted sleep due to neighbourhood disturbance. Similarly to Donnelly and Poynton's NSW-based study [80], Wilkinson and Livingston also indicated a decreased likelihood of property damage among those living further from an off-premise outlet, but because this measure did not involve an injury, these alcohol-related incidents would not be reflected in studies using hospital-based outcome data.

If proximity (the convenience cost or ease of accessing alcohol) were a major mediator of the relationship between sales and alcohol-related injury, it would be expected that the associations between off-premise sales and injury would be larger in the smaller buffer zone models than in models including outlets up to 5km from the centroid. However, the association between alcohol-related injury and off-premise sales was strongest in the larger buffer model at postcode level[73], suggesting that distance travelled (convenience cost) was a less important mediator in the association between sales and injury than other factors—for instance average or minimum retail price, staff service levels, choice of beverages and so on (as described in 6.2.2). In other words, factors other than proximity might be mediating the association between off-premise sales per outlet and alcohol-related injury. The online survey suggested that consumers are prepared to travel greater distances to purchase discounted liquor. Nearly 23% of participants were prepared to travel up to 5km further and an additional 33% of participants would travel 5 to 10km further to obtain a 30% discount on price at a bottle shop (Table 6.13). In the light of these findings, the greater risk of alcohol-related injury demonstrated in the statistical models using the largest buffer zone (5km) may be explained by patrons travelling further to purchase larger volumes of discounted alcohol.

The association between counts of on-premise outlets and alcohol-related injury was strongest within 1km of the geographic centroid; this association disappeared in the 5km buffer zone models. With harms such as assault, 'decay' is expected as the distance from an on-premise outlet increases: that is, the outlet will have declining influence on risk of assault further from the outlet, leading to weaker associations between harm and outlet counts as distance from the outlet increases [378, 380]. Although intoxicated patrons may return to residential settings, alcohol purchased at on-premise outlets is largely consumed on the

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[73] The association between alcohol-related injury and off-premise sales was stronger in the smallest buffer zone for models at suburb level. However, the quality of the data was better at postcode level (see 4.6.2 and 7.2.8) and the differences between the IRRs across the different postcode buffer zone models were significant, so postcode-level models were considered to be more valid.

property[74], and it is therefore reasonable to expect a decreasing risk of harms such as injury as distance from the outlet increases. Conversely, off-premise outlets function primarily as sources of alcohol rather than places of drinking. Alcohol purchased at these outlets is consumed in the home, private residences, at restaurants allowing 'BYO'[75] alcohol and so on.

The different effects of 'distance to outlet' by outlet type may also be related to how the geographic centroid functions in relation to on- and off-premise outlets. It may function as an 'average place of residence', as an 'individual place of residence' and may even approximate or be located near to a small-scale commercial centre or 'entertainment district' within a postcode or suburb—the latter possibility may be particularly relevant for on-premise outlets as restaurants, hotels and nightclubs tend to cluster more than off-premise outlets (see Map 7.2). This clustering at or near the postcode centroid would result in higher risk of alcohol-related injury in the models including the smaller buffer zones than in the 5km buffer zone. Conversely, off-premise outlets tend to be more dispersed within postcodes (Map 7.2) and less likely to cluster near the centroid. As a result, the smaller buffer zone models do not reflect a higher risk of injury than the larger buffer zones.

The influence of distance from the CBD on associations between alcohol availability and alcohol-related injury

The Perth Metropolitan Area has historically been structured around a CBD, with residential postcodes fanning out from this central point to the north, south, east and (to a lesser extent) west [454]. Smaller commercial centres have developed across the metropolitan area [454]. To model for differences in the road structure and patterns of travel across the metropolitan area, a framework introduced by Luk [435] was used in this study. The framework divides Perth into concentric zones, using the CBD as a central point. The single postcode 6000 was ultimately selected to represent the subjective concept of 'CBD'. Initial analysis stratified postcodes into three zones beyond the CBD (CBD to 7km, 7km to 15km, and 15km or more from the CBD).

Models that included postcodes and suburbs between the CBD and 7km from the CBD demonstrated that counts of on-premise outlets were significantly associated with both Night2 and Weekend Night2 injury. This was evident in the total postcode and suburb

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[74] Hotel, tavern and club licences allow sale of packaged liquor to patrons for consumption off the premise [464].
[75] BYO: Bring your own alcohol, that is, the alcohol is purchased elsewhere, e.g. a bottle shop, and then consumed at a restaurant.

models, and models including outlets within a 1km and 2km buffer from the centroid. The associations were strongest in the suburb-level models, and weakest in the 2km buffer models.

The postcodes (and suburbs) in this zone are relatively small compared to those beyond 7km from the CBD. For the same distance travelled, travel times are longer than outer postcodes, because of shorter distances between traffic signals and greater congestion. This zone includes areas such as Northbridge and Leederville which contain clusters of on-premise outlets such as nightclubs and restaurants—some of the major entertainment districts in the Perth Metropolitan Area. These areas are most likely to experience the negative (amenity) effects of alcohol outlets, because of clustering of (largely) on-premise outlets, and crowds of drunken patrons moving between venues. In fact, these areas are well known for having the highest levels of alcohol-related violence in Perth [461]. It is therefore unsurprising that counts of on-premise alcohol outlets were significantly and strongly associated with alcohol-related injury in this area. Furthermore, when counts of outlets and their sales were controlled for, postcodes between the CBD and 7km from the CBD were associated with an increased risk of alcohol-related injury compared to other postcodes in the metropolitan area.

The total outlet models for the middle postcodes (between 7km and 15km around the CBD) demonstrated that higher sales per off-premise outlet were associated with an increased risk of alcohol-related injury. This association was not evident in the buffer zone models or suburb-level models. These postcodes include a mix of residential areas and smaller commercial centres, such as Osborne Park and Cannington. Those living in this area travel relatively short distances to work and shopping centres (compared to those in the outer postcodes), but the travel times are shorter than in the inner postcodes because of the different road structure. Because geographical location and external cause of injuries were unknown, it was not possible to determine whether off-premise sales were associated purely with injuries occurring at homes and private parties (assault, intimate partner and family violence, and road crashes), or also with violence or road crashes occurring at or near on-premise outlets. The strong association between off-premise sales and injury, and the lack of association between on-premise sales and alcohol-related injury suggests that off-premise sales may be mediating the association between on-premise outlets and injury in this part of Perth. Liang and Chikritzhs have suggested that sales per off-premise outlet may be associated with incidents of alcohol-related harms occurring at or near on-premise outlets through pre-loading, that is, using alcohol purchased at off-premise outlets prior to attending on-premise outlets [22]. These on-premise outlets may be located some distance from the off-premise outlets, for example in the entertainment districts near the CBD. Further, off-premise sales represent BYO alcohol consumed at restaurants in other locations.

The results demonstrated in this study for the inner and middle postcodes of Perth concur with those of Livingston [15] in his study of the association between assault and outlet density in Melbourne. Livingston demonstrated that assault was strongly associated with hotel outlet density (on-premise) in the inner city, but with off-premise outlet density in suburban Melbourne.

Models for the postcodes beyond 15km from the Perth CBD demonstrate significant associations between sales per on-premise outlet and alcohol-related injury at postcode level, and between sales per off-premise outlet and alcohol-related injury at suburb level. In the outer areas of the metropolitan area, postcodes can contain up to four suburbs, and suburbs may straddle more than one postcode. Thus, the mechanism of action through which alcohol availability and injury are associated may differ substantially from the inner postcodes and suburbs. At postcode level, both counts and sales of on-premise outlets were significantly associated with alcohol-related injury in the total outlet models. The large association between sales per on-premise outlets and injury may be related to a greater influence of price on purchases at on-premise outlets (and therefore consumption levels) in the outer metropolitan area. Prices may be lower at on-premise outlets in the outer metropolitan area than in the trendy inner-city eateries and clubs, encouraging greater levels of consumption[76].

The 'routine activities' of those living in these postcodes may differ somewhat from those in the inner postcodes. Those living in these outer areas will be accustomed to travelling greater distances at greater speeds because of less congestion and longer distances between traffic signals. Therefore, proximity to outlets may be less important than price (e.g. bulk discounts), trading hours, ambience of outlets, selection of beverages, customer service and staff's knowledge about wines, and opportunities to use a loyalty card (factors indicated by online survey participants as influencing their choice of outlet— 6.2.2).

Livingston suggests that on- and off-premise outlets may function differently depending on the area of the city in which they are located [15]. Furthermore, the mix of types of outlets will differ across the city, which may influence how different outlet types are 'used' by drinkers [15]. Livingston proposes that in suburban areas further from the CBD, where there are fewer on-premise outlets, residents may use off-premise outlets as *"places to*

[76] For example, a restaurant in Subiaco charges $14 for a cocktail [465]. Another branch of the same restaurant in Armadale, an outer suburb, charges $12.50 for the identical cocktail [466].

meet and entertain themselves" (p. 1,077 [15]), and that, depending on the mix of on-premise licence types, hotels and restaurants may function differently from how they function closer to the CBD. This results in varying 'routine drinking activities' in different areas, affecting the risk distribution of alcohol-related harms [191].

Trading hours

A unique feature of this study was the analysis of the independent associations between both alcohol sales and counts of outlets by category of trading hours, and alcohol-related injury. A very small proportion of off-premise outlets in the Perth Metropolitan Area had permits allowing extended trading hours, so all off-premise outlets were grouped together. On-premise outlets were disaggregated into those with standard and those with extended trading hours. This study showed that the risk of alcohol-related injury was greater with an additional on-premise outlet with extended trading hours, compared to an additional on-premise outlet with standard trading hours (controlling for counts of off-premise outlets and sales at both on- and off-premise outlets). Sales per on-premise outlet were either not or negatively associated with alcohol-related injury. This suggests that for on-premise outlets, the number of venues trading with extended hours is a more important predictor of injury risk than the volume of sales per outlet. Chikritzhs and Stockwell [225, 226] showed that, compared to those with standard trading hours, hotels with late trading had significantly higher levels of violence and associated road crash injury. They also postulated that both the number of patrons and the increase in volume of alcohol consumed per patron may mediate the relationship between extended trading hours and harm. The current study suggested that it is the number of on-premise outlets (and possibly the number of patrons) rather than alcohol sales volumes that mediates this relationship.

8.3.3 The association between alcohol availability and socio-demographic factors

A variety of geographic area-level socio-economic and demographic factors were included as predictors in the statistical models constructed in this study. Associations between different socio-demographic variables and alcohol-related injury varied, depending on the model type (postcode or suburb, and total or buffer zone models), indicating that most associations were not robust. However, postcodes and suburbs with higher proportions of Indigenous residents and areas in a higher SEIFA quartile were consistently associated with a higher risk of presentation at an ED with an alcohol-related injury.

Stockwell and Gruenewald propose that *"Greater adverse health and social problems stemming from alcohol use will appear across the drinking population, focused in* *those subpopulations most exposed to risk. These risks will be distributed differently across population subgroups, depending upon differences in routine drinking activities."* (p. 217 [191]). From the results in this study, it appears that Indigenous people and people living in areas of higher socio-economic status are at greater risk of problems resulting from alcohol use. However, it is important to note that any conclusions about the importance of these findings are limited by the fact that these are group-level, not individual-level, data. Therefore, ecological fallacy could lead to incorrect conclusions being drawn from the results. For example, while postcodes with a higher proportion of Indigenous residents are associated with higher risk of alcohol-related injury, it may be that it is the non-Indigenous residents living in these postcodes who are at an increased risk of alcohol-related injury, rather than the Indigenous residents.

With this limitation in mind, previous Australian research has shown that people of Indigenous origin are at increased risk of harmful drinking [451] and alcohol-related harm [467, 468], compared to non-Indigenous Australians. Jobes and colleagues found significant associations in rural NSW between high proportions of Indigenous people per LGA and both assault and 'break and enter' crimes [469]. These authors suggested that the association between Indigenous status and alcohol-related harm might operate through higher levels of social disorganisation and instability in these postcodes, through *"a lack of shared values and beliefs among members of a community, and an inability to solve common problems"* (p. 118 [469]).The causes of social disorganisation were proposed to be *"colonisation and dispossession [which] produced a breakdown of Indigenous informal social controls"* (p. 219 [470]).

Recently, Grubesic and Pridemore demonstrated that as community social organisation increases, the association between outlet density and assault weakens [214]. The current study did not explore social disorganisation overtly, but, given the history of the Indigenous people in Australia, it provides a viable explanation of the strong association between postcodes with high proportions of Indigenous residents, and alcohol-related harms.

Most of the models developed in this study have demonstrated that postcodes in the highest SEIFA quartile (that is, the postcodes with the highest levels of socio-economic advantage and lowest levels of disadvantage) are associated with a higher risk of ED presentation with an alcohol-related injury. In an Australian study, Dietze and colleagues showed that LGAs with larger income inequalities (measured by the Gini coefficient) were at greater risk of alcohol-related harm than LGAs with more equitable incomes [471]. Other research (including alcohol availability research) has demonstrated that lower individual- and group-level socio-economic status are associated with increased risk of negative health outcomes including including injury (e.g. [472, 473]) and with increased incidence of problem drinking (e.g. [275, 474, 475]). Furthermore, areas with lower socio-economic status have been associated with higher outlet density (e.g. [305]), closer proximity to outlets (e.g. [281] and increased risk of alcohol-related harm (e.g. [340]). Research on outlet density and problem drinking has indicated outlet clustering [315] and higher outlet densities [275, 305] in the areas with the highest neighbourhood deprivation. However, a greater proportion of those living in areas of lower neighbourhood deprivation and higher individual socio-economic status were classified as heavy drinkers [472, 476].

The cause of the association between higher SEIFA and alcohol-related harm may lie in the calculation of the index. The SEIFA Index of Relative Socio-Economic Advantage and Disadvantage was used in this study. The exact components and relative weightings of these components vary from one census to another. The 2006 index consisted of variables describing the proportion of people in the area; income (high or low); education (schooling and tertiary qualifications); unemployment; skill level of occupation; rent (low, and number of bedrooms), and various other variables (such as disability, English skill, Indigenous status, car and internet access, and one-parent families) (p. 16 [452]). The emphasis in the index on income level, education and skill level suggests that those with a higher SEIFA of relative advantage/disadvantage have more disposable income and thus have more money to spend on alcohol. The online survey indicated that a higher proportion of those residing in the highest SEIFA postcodes in metropolitan Australia consumed alcohol at restaurants compared to those residing in lower SEIFA postcodes (6.2.5). Furthermore, Livingston showed that, while liquor shops and licensed clubs were more likely to be located in areas of lower socio-economic status in urban Victoria, higher densities of hotels and restaurants occurred in areas of higher socio-economic status [477]. Gruenewald and colleagues hypothesised that the significant association between restaurant density and driving after drinking might be mediated by higher income, as this group of drinkers was likely to have more available income to use on travel by car and on restaurant meals [294]. As alcohol price increases, research has shown that levels of alcohol consumption and harm drop [219, 233]. However, those with more disposable income are able to afford alcohol despite increased prices [478].

8.4 Recommendations

8.4.1 EDIS

While the EDIS reliably records almost all the ED presentations at Perth hospitals, data recording issues remain. Basic demographic details such as age and gender, and details such as time of presentation, postcode of residence and ICD-10 were consistently recorded. However, better recording of other demographic details, such as marital status and Indigenous status, would improve the quality of data, enabling more accurate targeting of injury prevention efforts. Furthermore, the mandatory inclusion of external causes codes (as recommended by [109]) would enable classification of injuries by type (e.g. pedestrian injury, assault etc.) and severity.

Considering the high proportion of ED cases in Australia that involve alcohol (estimates range from 22% [142] to 34% [140, 144]), the case can be argued for introducing mandatory blood alcohol testing of all ED presentations over the age of 15 years. It would be useful both to clinicians and researchers, enabling researchers to identify alcohol-related cases directly rather than relying on aetiological fractions or surrogate measures of alcohol-related harm.

8.4.2 Liquor licences

This study suggests that polices to prevent alcohol-related harm associated with on- and off-premise outlets should be approached differently, because of differing mechanisms mediating the associations of alcohol-related harm with the outlet types. For example, factors which indicate potential volume of sales, such as the floor area, fridge space or shelf space of an off-premise outlet, might influence the risk of alcohol-related injury more than the number of outlets, while direct controls of outlet density might be ineffective. Controlling the size (through restrictions on floor-space and volume of alcohol on sale) of outlets through licence restrictions might be a more effective way of reducing alcohol-related injury than restricting the number of off-premise licences granted. Further research is needed to explore potential proxy measures for alcohol sales volumes in order to assist decisions about future liquor licence applications. Off-premise outlets may be weighed by shelf space or floor area, and on-premise outlets by maximum capacity, to differentiate between size of outlet.

Moreover, retail price is likely to have a substantial influence on the decision of consumers to purchase alcohol and on the volume purchased at off-premise outlets [219, 459]. Alcohol consumers have a certain level of disposable income, so controlling price, either through a minimum floor price or by limiting discounts and special offers, has the potential to reduce sales at bottle shops [235] and elsewhere, and thereby reduce alcohol-related injury. Research has shown that increasing taxes on alcohol (and thereby retail price) has the potential to reduce alcohol-related disease and injury [233]. In addition to a volumetric taxation approach (wine is not taxed by alcohol content in Australia), increasing the minimum floor price on the cheapest alcoholic beverages (such as cask wine) may be especially effective in this regard [232]. Further Australian research on the implications of price-based interventions for addressing alcohol-related harm is needed as only a handful of studies have been conducted on this population (e.g. [238, 479]. The granting of licences to large warehouse-style ‘superstore’ outlets (favoured by the big chains, including supermarket chains) should be limited, as their capacity for price discounting and loss leading is substantial [480].

With regard to on-premise outlets, when sales and counts of off-premise outlets were controlled for, counts of on-premise outlets remained positive and significant in most models. The mechanism of amenity suggests that this may not be related merely to the absolute number of outlets, but to clustering of on-premise outlets. Thus, decisions on the granting of liquor licences should consider not only the absolute number of licences (such as by introducing a ceiling e.g. a maximum number of outlets per 10,000 population), but also the relative geographical position of on-premise outlets, and should assess potential negative effects that adding an outlet could have on the surrounding community via the amenity effect. Particular attention should be paid to the granting of licences in entertainment districts.

8.4.3 Alcohol-related harm levels

Preparation of EDs to cope with alcohol-related injury cases

This longitudinal study has confirmed previous ED research, indicating that most alcohol-related injuries present between midnight and 5 am. Even higher proportions of injuries presenting over the weekend involve alcohol. These findings can be used to inform choices on Perth ED staffing levels to cope with the influx of alcohol-related cases, providing both treatment and brief interventions. Health care professionals, particularly in EDs, can undertake screening, brief interventions and referral to specialist substance-use care. Evidence demonstrates that brief interventions are effective in reducing alcohol-related harm, specifically injuries, although they do not reduce alcohol consumption levels in the long-term [198, 481, 482].

Target populations

This study has shown that certain population-level characteristics were associated with alcohol-related injury. However, targeting these groups might be inappropriate as these findings could represent ecological fallacy—that population-level data is inappropriately extrapolated to the individual level. For example, postcodes and suburbs with higher proportions of residents of Indigenous origin were strongly positively associated with alcohol-related injury. However, it might be that those at higher risk of alcohol-related injury were not of Indigenous origin but lived in areas with a higher proportion of Indigenous residents. Similarly, although postcodes or suburbs in the highest SEIFA category were associated with a higher risk of alcohol-related injury, this risk could not necessarily be linked to individuals living in these areas. These trends would need to be confirmed by reliable individual-level data (e.g. with the data from a well-designed survey such as the National Drug Strategy Household Survey). If these results were confirmed, then targeted interventions to prevent alcohol-related harm might be appropriate.

8.5 Conclusion

Alcohol-related injuries, emanating from assault, road crashes and other causes, remain a worrying and ongoing problem arising from alcohol consumption in Perth and other parts of Australia. This research provides evidence of the differing associations between the number of alcohol outlets, sales per outlet, trading hours and alcohol-related injury. Specifically, the evidence points to complex relationships between availability and alcohol-related injury, depending on type of outlet, geographic location and the presence or absence of extended trading hours. This suggests that liquor licensing policies need to be informed, adaptable and able to differentiate among outlet types. The results provide evidence which can be used to inform alcohol policy and liquor licensing decisions in the future.

9 References

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1. BABOR, T., CAETANO, R., CASSWELL, S. et al. (2010) *Alcohol: No Ordinary Commodity. Research and public policy.* (Oxford, Oxford University Press).
2. FITZGERALD, R. & JORDAN, T. L. (2009) *Under the influence: a history of alcohol in Australia* (Sydney, Harper Collins Publishers Australia).
3. ROOM, R. (2010) The long reaction against the wowser: the prehistory of alcohol deregulation in Australia, *Health Sociology Review*, 19, 151-163.
4. BRUUN, K., EDWARDS, G., MARTTI, L. et al. (1975) *Alcohol Control Policies in Public Health Perspective* (Finland).
5. EDWARDS, G., ANDERSON, P., BABOR, T. et al. (1994) *Alcohol policy and the public good* (Oxford, Oxford University Press).
6. IRELAND, C. S. & THOMMENY, J. L. (1993) The crime cocktail: licensed premises, alcohol and street offences, *Drug and Alcohol Review*, 12, 143-150.
7. Anti-social behaviour strategy: 2009-2011 (Perth, Western Australia Police).
8. LIANG, W., CHIKRITZHS, T., PASCAL, R. & BINNS, C. W. (2011) Mortality rate of alcoholic liver disease and risk of hospitalization for alcoholic liver cirrhosis, alcoholic hepatitis and alcoholic liver failure in Australia between 1993 and 2005, *Internal Medicine Journal*, 41, 34-41.
9. BEGG, S., VOS, T., BARKER, B., STANLEY, L. & LOPEZ, A. (2008) Burden of disease and injury in Australia in the new millennium: measuring health loss from diseases, injuries and risk factors, *Medical Journal of Australia*, 188, 36-40.
10. NATIONAL PREVENTATIVE HEALTH TASKFORCE. Technical report no 3: preventing alcohol-related harm in Australia: a window of opportunity. Commonwealth of Australia, 2008.
11. SCRIBNER, R. A., MACKINNON, D. P. & DWYER, J. H. (1994) Alcohol outlet density and motor vehicle crashes in Los Angeles County cities, *Journal of Studies on Alcohol*, 55, 447-453.
12. STEVENSON, M., BREWER, R. & LEE, V. (1998) The spatial relationships between licensed alcohol outlets and alcohol-related motor vehicle crashes in Gwinnett County, Georgia, *Journal of Safety Research*, 29, 197-203.
13. NORSTRÖM, T. (2000) Outlet density and criminal violence in Norway, 1960-1995, *Journal of Studies on Alcohol*, 61, 907-911.
14. ZHU, L., GORMAN, D. M. & HOREL, S. (2004) Alcohol outlet density and violence: a geospatial analysis, *Alcohol and Alcoholism*, 39, 369-375.
15. LIVINGSTON, M. (2008) A longitudinal analysis of alcohol outlet density and assault, *Alcoholism: Clinical and Experimental Research,* 32, 1074-1079.
16. TRENO, A. J., JOHNSON, F. W., REMER, L. & GRUENEWALD, P. (2007) The impact of outlet densities on alcohol-related crashes: a spatial panel approach, *Accident Analysis and Prevention*, 39, 894-901.
17. SPEER, P. W., GORMAN, D. M., LABOUVIE, E. W. & ONTKUSH, M. J. (1998) Violent crime and alcohol availability: relationships in an urban community, *Journal of Public Health Policy,* 19, 303-318.
18. TATLOW, J. R., CLAPP, J. D. & HOHMAN, M. M. (2000) The relationship between geographic density of alcohol outlets and alcohol-related hospital admissions in San Diego County, *Journal of Community Health*, 25, 79-88.
19. GRUENEWALD, P. J. & REMER, L. (2006) Changes in outlet densities affect violence rates, *Alcoholism: Clinical and Experimental Research,* 30, 1184-1193.

20. GRUENEWALD, P. J., JOHNSON, F. W., MILLAR, A. B. & MITCHELL, P. R. (2000) Drinking and driving: explaining beverage-specific risks, *Journal of Studies on Alcohol*, 61, 515-523.
21. CHEN, M. J., GRUBE, J. W. & GRUENEWALD, P. (2010) Community alcohol outlet density and underage drinking, *Addiction*, 105, 270-278.
22. LIANG, W. & CHIKRITZHS, T. (2011) Revealing the link between licensed outlets and violence: counting venues versus measuring alcohol availability, *Drug and Alcohol Review*, 30, 524-535.
23. STEVENSON, M., LIND, B. & WEATHERBURN, D. (1999) The relationship between alcohol sales and assault in New South Wales, Australia, *Addiction*, 94, 397-410.
24. CHERPITEL, C. J. (1993) Alcohol and injuries: a review of international Emergency Room studies, *Addiction*, 88, 923-937.
25. CHERPITEL, C. J. (2007) Alcohol and injuries: a review of international Emergency Room studies since 1995, *Drug and Alcohol Review*, 26, 201-214.
26. CUNRADI, C. B., MAIR, C., PONICKI, W. & REMER, L. (2012) Alcohol outlet density and intimate partner violence-related Emergency Department visits, *Alcoholism: Clinical and Experimental Research*.
27. DESCALLAR, J., MUSCATELLO, D. J., WEATHERBURN, D., CHU, M. & MOFFATT, S. (2011) The association between the incidence of Emergency Department attendances for alcohol problems and assault incidents attended by police in New South Wales, Australia, 2003-2008: a time-series analysis, *Addiction*, 107, 549-556.
28. THE MEASUREMENT OF ALCOHOL PROBLEMS FOR POLICY. A first report of research in progress. Perth, WA: National Centre for Research into the Prevention of Drug Abuse, Curtin University, 1995.
29. CHIKRITZHS, T., CATALANO, P., PASCAL, R. & HENRICKSON, N. Predicting alcohol-related harms from licensed outlet density: a feasibility study. Monograph series no. 28. Hobart: 2007.
30. CHIKRITZHS, T. N. The impact of extended trading hours in licensed premises on indicators of alcohol-related harm. Perth: Curtin University of Technology; 2004.
31. SOUTH WEST ABORIGINAL LAND AND SEA COUNCIL. Kaartdijin Noongar: sharing Noongar culture. 2010 [19 February 2013]; Available from: http://www.noongarculture.org.au/homepage.aspx.
32. NEVILL, S. J. (2007) *Perth and Fremantle: Past and Present* (Western Australia, Simon Nevill Publications).
33. EDWARDS, I. E. (2002) *Headlines of history: a chronicle of Western Australian history* (Flying Fish Ventures).
34. GOVERNMENT OF WESTERN AUSTRALIA. Drug and Alcohol Office: Government of Western Australia. 2013 [updated 7 March 2012; cited 2013 1 September]; Available from: http://www.dao.health.wa.gov.au/Aboutus.aspx.
35. CHIKRITZHS, T., ALLSOP, S., MOODIE, A. R. & HALL, W. D. (2010) Per capita alcohol consumption in Australia: will the real trend please step forward?, *Medical Journal of Australia*, 193, 1-4.
36. ABS. 4307.0.55.001 - Apparent Consumption of Alcohol, Australia, 2008-09. Canberra: 2010 17 October 2010. Report No.
37. LOXLEY, W., CATALANO, P., GILMORE, W. & CHIKRITZHS, T. National Alcohol Sales Data Project stage three: final report. Perth, Western Australia: National Drug Research Institute, Curtin University, 2012.
38. ABS. 4307.0.55.001 - Apparent Consumption of Alcohol, Australia, 2004-05. Canberra: 2006 Contract No.: 4307.0.55.001.
39. XIAO, J., ROWE, T., SOMERFORD, P., DRAPER, G. & MARTIN, J. Impact of alcohol on the population of Western Australia. Epidemiology Branch, Department of Health WA, 2008.
40. LOXLEY, W., GRAY, D., WILKINSON, C. et al. (2005) Alcohol policy and harm reduction in Australia, *Drug and Alcohol Review*, 24, 559-568.

41. BABOR, T., CAETANO, R., CASSWELL, S. et al. (2010) Regulating the physical availability of alcohol *Alcohol: No Ordinary Commodity*, pp. 127-146 (Oxford, Oxford University Press).
42. SMART, R. G. (1980) Availability and the prevention of alcohol-related problems, in: Harford, T. C., Parker, D. A. & Lights, L. (Eds.) *Normative Approaches to the Prevention of Alcohol Abuse and Alcoholism*, pp. 123-146 (Washington, DC, U.S. Government Printing Office).
43. MIDFORD, R. (2005) Australia and alcohol: living down the legend, *Addiction*, 100, 891-896.
44. DINGLE, A. E. (1980) "The truly magnificent thirst": an historical survey of Austrlian drinking habits, *Historical Studies: Australia and New Zealand*, 19, 227-249.
45. PALK, G. R., DAVEY, J. D. & FREEMAN, J. E. Parliamentary inquiry into alcohol-related violence. Brisbane, Qld: Law, Justice and Safety Committee,, 2009.
46. ROOM, R. (1988) The dialectic of drinking in Australian life: from the Rum Corps to the wine column, *Australian Drug and Alcohol Review*, 7, 413-437.
47. PHILLIPS, W. (1980) "Six o' clock swill": the introduction of early closing of hotel bars in Australia, *Historical Studies: Australia and New Zealand*, 19, 250-266.
48. AUSTRALIAN NATIONAL DICTIONARY CENTRE. Meanings and origins of Australian words and idioms. 2013 [cited 2013 20 August]; Available from: http://andc.anu.edu.au/australian-words/meanings-origins?field_alphabet_value=281.
49. TRIFONOFF, A., ANDREW, R., STEENSON, T., NICHOLAS, R. & ROCHE, A. M. Liquor licensing legislation in Australia: an overview. Adelaide, SA: National Centre for Education and Training on Addiction (NCETA). Flinders University, 2011.
50. ZAJDOW, G. (2011) Producing the market for alcohol : the Victorian example, *Journal of Australian Studies*, 35, 83-98.
51. NATIONAL LOCAL GOVERNMENT DRUG AND ALCOHOL ADVISORY COMMITTEE. Submission to the MCDS, National Alcohol Forum: local government recommendations on liquor licensing. Canberra: 2008 15 July. Report No.
52. NIEUWENHUYSEN, J. Review of the Liquor Control Act 1968, Victoria. Melbourne: Department of Industry, Commerce and Technology, 1985.
53. SANTAMARIA, J. N. (1986) The Nieuwenhuysen Report, *Australian Drug and Alcohol Review*, 5, 265-266.
54. CHIKRITZHS, T. (2009) Australia, in: Hadfield, P. (Ed.) *Nightlife and Crime: Social Order and Governance in International Perspective*, pp. 307-330 (New York, Oxford University Press).
55. LOXLEY, W., PASCAL, R., LYONS, Z., CHIKRITZHS, T. & ALLSOP, S. Alcohol consumption and harm: a comparison of liquor licensing and other relevant issues in Western Australia and other Australian jurisdictions. Perth, Western Australia: National Drug Research Institute, Curtin University of Technology, 2007 December 2007. Report No.
56. Liquor Licensing Act 1988, Pub. L. No. 55(9 December, 1988).
57. NATIONAL COMPETITION COUNCIL. Assessment of governments' progress in implementing the National Competition Policy and related reforms: June 2001. Canberra: 2001.
58. Liquor Control Act 1988, (29 November 2012, 2012).
59. GRAY, D., SAGGERS, S., ATKINSON, D., SPUTORE, B. & BOURBON, D. (2000) Beating the grog: an evaluation of the Tennant Creek liquor licensing restrictions, *Australian and New Zealand Journal of Public Health*, 24, 39-44.
60. GRAY, D., SAGGERS, S., ATKINSON, D., SPUTORE, B. & BOURBON, D. Evaluation of the Tennant Creek liquor licensing restrictions: a report prepared for the Tennant Creek Beat the Grog Sub-Committee. Perth, Australia: Curtin University of Technology, National Centre for Research into the Prevention of Drug Abuse, 1998.

61. BRADY, M. (2000) Alcohol policy issues for Indigenous people in the United States, Canada, Australia and New Zealand, *Contemporary Drug Problems*, 27, 435-509.
62. MARGOLIS, S. A., YPINAZAR, V. A., MULLER, R. & CLOUGH, A. (2011) Increasing alcohol restrictions and rates of serious injury in four remote Australian indigenous communities, *Medical Journal of Australia*, 194, 503-506.
63. TRIFONOFF, A., ANDREW, R., STEENSON, T., NICHOLAS, R. & ROCHE, A. M. Liquor licensing legislation in Australia: a jurisdictional breakdown. Adelaide, SA.: National Centre for Education and Training on Addiction (NCETA). Flinders University, 2011.
64. Liquor Act 2007: New South Wales, Act 90 of 2007 (2007).
65. Liquor Control Reform Act 1998: Victoria, No. 94 of 1998 (1998).
66. Liquor Act 1992: Queensland, (1992).
67. Liquor Licensing Act 1997: South Australia, (1997).
68. Liquor Control Act 1990: Tasmania, Act 44 of 1990 (1990).
69. Liquor Act: Northern Territory.
70. Liquor Act 2010: ACT, (2010).
71. Liquor Regulation 2008: New South Wales, Reg 240 of 2008 (2008).
72. Liquor Control Reform Regulations 2009: Victoria, Reg 134 of 2009 (2009).
73. Liquor Regulations 2002: Queensland, (2002).
74. Liquor Licensing (General) Regulations 2012: South Australia, (2012).
75. Liquor Control Regulations 1989: Western Australia, (1989).
76. Liquor Licensing Regulations 2002: Tasmania, Regulation 96 of 2003 (2003).
77. Liquor Regulations: Northern Territory.
78. Liquor Regulation 2010: ACT, (2010).
79. NATIONAL COMPETITION COUNCIL (2003) Press Release: NCP does not require unrestricted sale of alcohol.
80. DONNELLY, N., POYNTON, S., WEATHERBURN, D., BAMFORD, E. & NOTTAGE, J. Liquor outlet concentrations and alcohol-related neighbourhood problems. Sydney: NSW Bureau of Crime Statistics and Research, 2006 Contract No.: 8.
81. DEPARTMENT OF RACING GAMING AND LIQUOR (2010) Liquor licensing: a guide to liquor licensing in Western Australia 2009/10.
82. NATIONAL COMPETITION COUNCIL. Assessment of governments' progress in implementing the National Competition Policy and related reforms. Volume one: assessment, August 2002. Canberra: 2002.
83. MARSDEN, J., TIKOTIN, C. & JONES, P. Identifying a framework for regulation in packaged liquor retailing. Marsden Jacob Associates for the National Commission Council, 2005.
84. LIANG, W. & CHIKRITZHS, T. (2010) Violence in the night-time economy: availability and amenity, Paper presented at the *Kettil Bruun Society Thematic Meeting on Alcohol and Violence*, Melbourne, 15th-18th March.
85. CHIKRITZHS, T., GRAY, D., LYONS, Z. & SAGGERS, S. Restrictions on the sale and supply of alcohol: evidence and outcomes. Perth: National Drug Research Institute, Curtin University of Technology, 2007.
86. DORAN, C. M., HALL, W. D., SHAKESHAFT, A. P., VOS, T. & COBIAC, L. J. (2010) Alcohol policy reform in Australia: what can we learn from the evidence?, *Medical Journal of Australia*, 192, 478-480.
87. AUSTRALIAN NATIONAL PREVENTIVE HEALTH AGENCY. Harmful alcohol use. 2013 [updated 6 May 2013; cited 2013 25 September]; Available from: http://anpha.gov.au/internet/anpha/publishing.nsf/Content/harmful-alcohol-use.
88. MATHERS, C., STEIN, C., FAT, D. et al. Global Burden of Disease 2000: version 2 methods and results. World Health Organisation 2002 Contract No.: Discussion paper number 50.

89. CORRAO, G., BAGNARDI, V., ZAMBON, A. & ARICO, S. (1999) Exploring the dose-response relationship between alcohol consumption and the risk of several alcohol-related conditions: a meta-analysis, *Addiction*, 94, 1551-1573.
90. CHERPITEL, C., BORGES, G., GIESBRECHT, N. et al. Alcohol and injuries: Emergency Department studies in an international perspective. Geneva: World Health Organisation 2009.
91. CHERPITEL, C. J. (1992) The epidemiology of alcohol-related trauma, *Alcohol Health and Research World*, 16, 191-191.
92. REHM, J., ROOM, R., MONTEIRO, M. et al. (2003) Alcohol as a risk factor for global burden of disease, *European Addiction Research*, 9, 157-164.
93. VINSON, D. C., MABE, N., LEONARD, L. L. et al. (1995) Alcohol and injury. a case-crossover study, *Archives of Family Medicine*, 4, 505-511.
94. BAZARGAN-HEJAZI, S., GAINES, T., DUAN, N. & CHERPITEL, C. J. (2007) Correlates of injury among ED visits: effects of alcohol, risk perception, impulsivity, and sensation seeking behaviors, *American Journal of Drug and Alcohol Abuse*, 33, 101-108.
95. NORTON, R. N. & MORGAN, M. Y. (1989) The role of alcohol in mortality and morbidity from interpersonal violence, *Alcohol and Alcoholism*, 24, 565-576.
96. BORGES, G., CHERPITEL, C. & ROSOVSKY, H. (1998) Male drinking and violence-related injury in the Emergency Room, *Addiction*, 93, 103-112.
97. VINSON, D. C., BORGES, G. & CHERPITEL, C. (2003) The risk of intentional injury with acute and chronic alcohol exposures: a case-control and case-crossover study, *Journal of Studies on Alcohol*, 64, 350-357.
98. KUENDIG, H., HASSELBERG, M., LAFLAMME, L., DAEPPEN, J. B. & GMEL, G. (2008) Alcohol and nonlethal injuries: a Swiss Emergency Department study on the risk relationship between acute alcohol consumption and type of injury, *Journal of Trauma: Injury, Infection and Critical Care*, 65, 203-211.
99. BORGES, G., CHERPITEL, C., OROZCO, R. et al. (2006) Acute alcohol use and the risk of non-fatal injury in sixteen countries, *Addiction*, 101, 993-1002.
100. BORGES, G., CHERPITEL, C. & MITTLEMAN, M. (2004) Risk of injury after alcohol consumption: a case-crossover study in the Emergency Department, *Social Science and Medicine*, 58, 1191-1200.
101. LANGLEY, J. & BRENNER, R. (2004) What is an injury?, *Injury Prevention*, 10, 69-71.
102. BAKER, S., O'NEILL, B., GINSBURG, M. & GUOHUA, L. (1992) *The Injury Factbook* (New York, Oxford University Press).
103. HADDON, W. (1963) A note concerning accident theory and research with special reference to motor vehicle accidents, *Annals of the New York Academy of Sciences*, 107, 635-646.
104. ROBERTSON, L. (2007) *Injury Epidemiology: Research and Control Strategies* (Oxford University Press).
105. HOLDER, Y., PEDEN, M., KRUG, E., GURURAJ, G. & KOBUSINGYE, O. Injury surveillance guidelines. Geneva: World Health Organisation, 2001 WHO/NMH/VIP/01.02.
106. WORLD HEALTH ORGANISATION. ICD-10 Version 2007. Available from: http://apps.who.int/classifications/apps/icd/icd10online/.
107. LANGLEY, J., CHALMERS, D. & FANSLOW, J. (1996) Incidence of death and hospitalization from assault occurring in and around licensed premises: a comparative analysis, *Addiction*, 91, 985-993.
108. CHERPITEL, C. J. (1994) Alcohol and injuries resulting from violence: A review of emergency room studies, *Addiction*, 89, 157-165.
109. CHIKRITZHS, T., EVANS, M., GARDNER, C. et al. Australian alcohol aetiologic fractions for injuries treated in Emergency Departments. Perth: National Drug Research Institute, Curtin University, 2011.

110. BORGES, G., CHERPITEL, C. J., MEDINA-MORA, M. E., MONDRAGÓN, L. & CASANOVA, L. (1998) Alcohol consumption in Emergency Room patients and the general population: a population-based study, *Alcoholism: Clinical and Experimental Research*, 22, 1986-1991.
111. ZEISSER, C., STOCKWELL, T. R., CHIKRITZHS, T. et al. (2013) A systematic review and meta-analysis of alcohol consumption and injury risk as a function of study design and recall period, *Alcoholism: Clinical and Experimental Research*, 37, E1-E8.
112. CHERPITEL, C. J., YE, Y., MOSKALEWICZ, J. & SWIATKIEWICZ, G. (2005) Risk of injury: a case-crossover analysis of injured emergency service patients in Poland, *Alcoholism: Clinical and Experimental Research*, 29, 2181-2187.
113. BORGES, G., OROZCO, R., CREMONTE, M. et al. (2008) Alcohol and violence in the Emergency Department: a regional report from the WHO collaborative study on alcohol and injuries, *Salud Publica de Mexico*, 50, S6-S11.
114. GMEL, G., KUENDIG, H., REHM, J., SCHREYER, N. & DAEPPEN, J. B. (2009) Alcohol and cannabis use as risk factors for injury - a case-crossover analysis in a Swiss hospital Emergency Department, *BMC Public Health*, 9.
115. WILLIAMS, M., MOHSIN, M., WEBER, D., JALALUDIN, B. I. N. & CROZIER, J. (2010) Alcohol consumption and injury risk: a case-crossover study in Sydney, Australia, *Drug and Alcohol Review*, no-no.
116. VINSON, D. C., MACLURE, M., REIDINGER, C. & SMITH, G. S. (2003) A population-based case-crossover and case-control study of alcohol and the risk of injury, *Journal of Studies on Alcohol*, 64, 358-366.
117. HONKANEN, R., ERTAMA, L., KUOSMANEN, P. et al. (1983) The role of alcohol in accidental falls, *Journal of Studies on Alcohol*, 44, 231.
118. BLOMBERG, R., PREUSER, D., HALE, A. & ULMER, R. A comparison of alcohol involvement in pedestrians and pedestrian casualities. Darien, Connecticut: U.S. Department of Transportation. National Highway Traffic Safety Administration, 1979 Contract No.: DOT-HS-805 249
119. CHERPITEL, C. J., BOND, J., YE, Y. et al. (2003) A cross-national meta-analysis of alcohol and injury: data from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), *Addiction*, 98, 1277-1286.
120. CHERPITEL, C. J., BOND, J., YE, Y. et al. (2003) Alcohol-related injury in the ER: a cross-national meta-analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), *Journal of Studies on Alcohol*, 64, 641-649.
121. CHERPITEL, C. J., BOND, J. & YE, Y. (2005) Alcohol and injury: a risk function analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), *European Addiction Research*, 12, 42-52.
122. CHERPITEL, C. J., YE, Y., BOND, J. et al. (2005) Multi-level analysis of alcohol-related injury among Emergency Department patients: a cross-national study, *Addiction*, 100, 1840-1850.
123. CHERPITEL, C. J., BOND, J., YE, Y. et al. (2006) Multi-level analysis of causal attribution of injury to alcohol and modifying effects: data from two international emergency room projects, *Drug and Alcohol Dependence*, 82, 258-268.
124. CHERPITEL, C. J., YE, Y., BOND, J. et al. (2006) The effect of alcohol consumption on Emergency Department services use among injured patients: a cross-national emergency room study, *Journal of Studies on Alcohol*, 67, 890-897.
125. MACDONALD, S., CHERPITEL, C. J., DESOUZA, A. et al. (2006) Variations of alcohol impairment in different types, causes and contexts of injuries: results of Emergency Room studies from 16 countries, *Accident Analysis and Prevention*, 38, 1107-1112.
126. WELLS, S., THOMPSON, J. M., CHERPITEL, C. et al. (2007) Gender differences in the relationship between alcohol and violent injury: An analysis of cross-national Emergency Department data, *Journal of Studies on Alcohol and Drugs*, 68, 824-833.

127. MACDONALD, S., CHERPITEL, C. J., BORGES, G. et al. (2005) The criteria for causation of alcohol in violent injuries based on Emergency Room data from six countries, *Addictive Behaviors*, 30, 103-113.

128. TAYLOR, B., IRVING, H. M., KANTERES, F. et al. (2010) The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together, *Drug and Alcohol Dependence*, 110, 108-116.

129. CHERPITEL, C. J. (1996) Drinking patterns and problems and drinking in the event: An analysis of injury by cause among casualty patients, *Alcoholism: Clinical and Experimental Research*, 20, 1130-1137.

130. WATT, K., PURDIE, D. M., ROCHE, A. M. & MCCLURE, R. (2006) Injury severity: role of alcohol, substance use and risk-taking, *Emergency Medicine Australasia*, 18, 108-117.

131. HONKANEN, R. & SMITH, G. S. (1990) Impact of acute alcohol intoxication on the severity of injury: a cause-specific analysis of non-fatal trauma, *Injury*, 21, 353-357.

132. CHARALAMBOUS, M. P. (2002) Alcohol and the Accident and Emergency Department: a current review, *Alcohol and Alcoholism*, 37, 307-312.

133. SHEPHERD, J., IRISH, M., SCULLY, C. & LESLIE, I. (1988) Alcohol intoxication and severity of injury in victims of assault, *British Medical Journal*, 296, 1299.

134. YAGHOUBIAN, A., KAJI, A., PUTNAM, B., DE VIRGILIO, N. & DE VIRGILIO, C. (2009) Elevated blood alcohol level may be protective of trauma patient mortality, *American Surgeon*, 75, 950-953.

135. YOONHEE, C., KOOYOUNG, J., EUNKYUNG, E. et al. (2009) The relationship between alcohol consumption and injury in ED trauma patients, *American Journal of Emergency Medicine*, 27, 956-960.

136. BRICKLEY, M. R. & SHEPHERD, J. P. (1995) The relationship between alcohol-intoxication, injury severity and Glasgow Coma Scale in assault patients, *Injury: International Journal of the Care of the Injured*, 26, 311-314.

137. SHAHIN, H., GOPINATH, S. P. & ROBERTSON, C. S. (2010) Influence of alcohol on early Glasgow Coma Scale in head-injured patients, *Journal of Trauma : Injury, Infection and Critical Care*, 69, 1176-1181.

138. LI, G., KEYL, P. M., SMITH, G. S. & BAKER, S. P. (1997) Alcohol and injury severity: reappraisal of the continuing controversy, *Journal of Trauma: Injury, Infection and Critical Care*, 42, 562-569.

139. JOHNSTON, J. J. E. & MCGOVERN, S. J. (2004) Alcohol related falls: an interesting pattern of injuries, *Emergency Medicine Journal*, 21, 185-188.

140. POYNTON, S., DONNELLY, N., WEATHERBURN, D., FULDE, G. & SCOTT, L. (2005) The role of alcohol in injuries presenting to St Vincent's Hospital Emergency Department and the associated short-term costs, *Alcohol Studies Bulletin*.

141. HAVARD, A., SHAKESHAFT, A. P., CONIGRAVE, K. M. & SANSON-FISHER, R. W. (2011) The prevalence and characteristics of alcohol-related presentations to Emergency Departments in rural Australia, *Emergency Medicine Journal*, 28, 290-295.

142. MCLEOD, R., STOCKWELL, T., STEVENS, M. & PHILLIPS, M. (1999) The relationship between alcohol consumption patterns and injury, *Addiction*, 94, 1719-1734.

143. STOCKWELL, T., MCLEOD, R., STEVENS, M. et al. (2002) Alcohol consumption, setting, gender and activity as predictors of injury: a population-based case-control study, *Journal of Studies on Alcohol*, 63, 372-379.

144. WATT, K., PURDIE, D. M., ROCHE, A. M. & MCLURE, R. J. (2004) Risk of injury from acute alcohol consumption and the influence of confounders, *Addiction*, 99, 1262-1273.

145. LI, Y. (2003) Feasibility of identification of alcohol intoxication by nurses in emergency departments, *Kaohsiung Journal of Medical Science*, 19, 391-396.

146. TRENO, A., COOPER, K. & ROEPER, P. (1994) Estimating alcohol involvement in trauma patients: search for a surrogate, *Alcoholism: Clinical and Experimental Research*, 18, 1306-1311.
147. TRENO, A., GRUENEWALD, P. & PONICKI, W. (1996) Use of ICD-9-CM codes in the estimation of alcohol-involved injury: search for a surrogate II, *Alcoholism: Clinical and Experimental Research*, 20, 320-326.
148. CHERPITEL, C. J. S., PARES, A., RODES, J. & ROSOVSKY, H. (1992) Validity of self-reported alcohol consumption in the Emergency Room: data from the United States, Mexico and Spain, *Journal of Studies on Alcohol*, 53, 203-207.
149. BOND, J., YE, Y., CHERPITEL, C. et al. (2010) The relationship between self-reported drinking and BAC level in emergency room injury cases: is it a straight line?, *Alcoholism: Clinical and Experimental Research*, 34, 1118-1125.
150. TRENO, A. J., GRUENEWALD, P. J. & JOHNSON, F. W. (1998) Sample selection bias in the emergency room: an examination of the role of alcohol in injury, *Addiction*, 93, 113-129.
151. SOMMERS, M. S., DYEHOUSE, J. M., HOWE, S. R. et al. (2000) Validity of self-reported alcohol consumption in nondependent drinkers with unintentional injuries, *Alcoholism: Clinical and Experimental Research*, 24, 1406-1413.
152. SOMMERS, M. S., DYEHOUSE, J. M., HOWE, S. R., WEKSELMAN, K. & FLEMING, M. (2002) "Nurse, I only had a couple of beers": validity or self-reported drinking before serious vehicular injury, *American Journal of Critical Care*, 11, 106-114.
153. INDIG, D., COPELAND, J., CONIGRAVE, K. M. & ROTENKO, I. (2008) Why are alcohol-related Emergency Department presentations under-detected? An exploratory study using nursing triage text, *Drug and Alcohol Review*, 27, 584-590.
154. INDIG, D., COPELAND, J., CONIGRAVE, K. M. & ARCURI, A. (2010) Characteristics and comorbidity of drug and alcohol-related Emergency Department presentations detected by nursing triage text, *Addiction*, 105, 897-906.
155. CHERPITEL, C. J., SOGHIKIAN, K. & HURLEY, L. B. (1996) Alcohol-related health services use and identification of patients in the Emergency Department, *Annals of Emergency Medicine*, 28, 418-423.
156. WORLD HEALTH ORGANISATION. International Classification of Diseases (ICD). 2013 [cited 2013 28 August]; Available from: http://www.who.int/classifications/icd/en/.
157. THE NATIONAL CENTRE FOR CLASSIFICATION IN HEALTH (2009) International Statistical Classification of Diseases and related health problems, tenth Revision, Australian Modification 7th edition (Sydney, Faculty of Health Sciences, The University of Sydney).
158. CHERPITEL, C. J., BOND, J., YE, Y. et al. (2005) Clinical assessment compared with breathalyser readings in the Emergency Room: concordance of ICD-10 Y90 and Y91 codes, *Emergency Medicine Journal*, 22, 689-695.
159. PIDD, K., BERRY, J. G., HARRISON, J. E. et al. Alcohol and work: patterns of use, workplace culture and safety. Adelaide: AIHW, 2006 Contract No.: INJCAT 82.
160. INDIG, D., COPELAND, J., CONIGRAVE, K. M. & ROTENKO, I. (2009) Attitudes and beliefs of Emergency Department staff regarding alcohol-related presentations, *International Emergency Nursing*, 17, 23-30.
161. MCKENZIE, K., HARRISON, J. E. & MCCLURE, R. J. (2010) Identification of alcohol involvement in injury-related hospitalisations using routine data compared to medical record review, *Australian and New Zealand Journal of Public Health*, 34, 146-152.
162. GENTILELLO, L. M., VILLAVECES, A., RIES, R. R. et al. (1999) Detection of acute alcohol intoxication and chronic alcohol dependence by trauma center staff, *Journal of Trauma: Injury, Infection and Critical Care*, 47, 1131-1139.
163. BRINKMAN, S., CHIKRITZHS, T., STOCKWELL, T. & MATHEWSON, P. (2001) An indicator approach to the measurement of alcohol-related violence, in: Williams, P.

(Ed.) *Alcohol, young persons and violence*, pp. 61-84 (Canberra, Australian Institute of Criminology).
164. EVANS, M., PASCAL, R. & CHIKRITZHS, T. South Australian Emergency Department presentations as indicators of alcohol-related harm: feasibility study. Stage 2: final report National Drug Research Institute, 2011.
165. STOCKWELL, T. & CHIKRITZHS, T. International Guide for Monitoring Alcohol Consumption and Related Harm. Department of Mental Health and Substance Dependence, Noncommunicable Diseases and Mental Health Cluster, World Health Organization, 2000 Contract No.: WHO/MSD/MSB/00.4.
166. STOCKWELL, T., CHIKRITZHS, T. & BRINKMAN, S. (2000) The role of social and health statistics in measuring harm from alcohol, *Journal of Substance Abuse*, 12, 139-154.
167. TRENO, A. J. & HOLDER, H. D. (1997) Measurement of alcohol-involved injury in community prevention: the search for a surrogate III, *Alcoholism: Clinical and Experimental Research*, 21, 1695-1703.
168. YOUNG, D. J., STOCKWELL, T., CHERPITEL, C. et al. (2004) Emergency Room injury presentations as an indicator of alcohol-related problems in the community: a multilevel analysis of an international study, *Journal of Studies on Alcohol*, 65, 605-612.
169. STOCKWELL, T., MASTERS, L., PHILIPS, M. et al. (1998) Consumption of different alcoholic beverages as predictors of local rates of night-time assault and acute alcohol-related morbidity, *Australian and New Zealand Journal of Public Health*, 22, 237-242.
170. BRISCOE, S. & DONNELLY, N. Assaults on licensed premises in inner-urban areas. Sydney: NSW Bureau of Crime Statistics and Research, 2001 October 2001. Report No.: Contract No.: 2.
171. HEEREN, T., SMITH, R. A., MORELOCK, S. & HINGSON, R. W. (1985) Surrogate measures of alcohol involvement in fatal crashes: are conventional indicators adequate?, *Journal of Safety Research*, 16, 127-134.
172. VOAS, R. B., ROMANO, E. & PECK, R. (2009) Validity of surrogate measures of alcohol involvement when applied to nonfatal crashes, *Accident Analysis and Prevention*, 41, 522-530.
173. KUENDIG, H., LAFLAMME, L., GMEL, G., DAEPPEN, J. B. & HASSELBER, M. (2010) Time of injury in light of prior-to-injury and usual alcohol consumption: an Emergency Department study, *Open Access Emergency Medicine*, 61-66.
174. WAGENAAR, A. C. & MAYBEE, R. G. (1986) The legal minimum drinking age in Texas: effects of an increase from 18 to 19, *Journal of Safety Research*, 17, 165-178.
175. BLOSE, J. O. & HOLDER, H. D. (1987) Public availability of distilled spirits: structural and reported consumption changes associated with liquor-by-the-drink, *Journal of Studies on Alcohol*, 48, 371-379.
176. WAGENAAR, A. C. & HOLDER, H. D. (1991) A change from public to private sale of wine: results from natural experiments in Iowa and West Virginia, *Journal of Studies on Alcohol*, 52, 162-173.
177. HOLDER, H. D. & WAGENAAR, A. C. (1994) Mandated server training and reduced alcohol-involved traffic crashes: a time series analysis of the Oregon experience, *Accident Analysis and Prevention*, 26, 89-97.
178. HINGSON, R., HEEREN, T. & WINTER, M. (1994) Lower legal blood alcohol limits for young drivers, *Public Health Reports*, 109, 738-744.
179. ROGERS, P. N. The general deterrant impact of California's 0.08% blood alcohol concentration limit and administrative per se license suspension laws. . Sacramento, CA: California Department of Motor Vehicles, 1995.
180. MCDERMOTT, F. T. & HUGHES, E. S. R. (1983) Drink-driver casualties in Victoria: peak periods on Thursday, Friday and Saturday nights, *Medical Journal of Australia*, 1, 606-608.

181. FABBRI, A., MARCHESINI, G., MORSELLI-LABATE, A. M. et al. (2002) Positive blood alcohol concentration and road accidents. a prospective study in an Italian emergency department, *Emergency Medicine Journal*, 19, 210-214.
182. KEALL, M. D., FRITH, W. J. & PATTERSON, T. L. (2005) The contribution of alcohol to night time crash risk and other risks of night driving, *Accident Analysis and Prevention*, 37, 816-824.
183. CHIKRITZHS, T. N., STOCKWELL, T. R., HEALE, P., DIETZE, P. & WEBB, M. Trends in alcohol-related road injury in Australia, 1990-1997. National Alcohol Indicator Project, Bulletin No. 2. Perth: National Drug Research Institute, Curtin University of Technology, 2000.
184. MÄKELÄ, P., MARTIKAINEN, P. & NIHTILÄ, E. (2005) Temporal variation in deaths related to alcohol intoxication and drinking, *International Journal of Epidemiology*, 34, 765-771.
185. SMITH, S. M., GOODMAN, R. A., THACKER, S. B. et al. (1989) Alcohol and fatal injuries: temporal patterns, *American Journal of Preventive Medicine*, 5, 296-302.
186. MCLEOD, R., STOCKWELL, T. R., STEVENS, M. A. & PHILLIPS, M. The influence of alcohol and drug use, setting and activity on the risk of injury - a case-control study. Perth, WA: National Drug Research Institute, Curtin University of Technology, 2000 Contract No.: 1-86342-904-2.
187. PULJULA, J., SAVOLA, O., TUOMIVAARA, V., PRIBULA, J. & HILLBOM, M. (2007) Weekday distribution of head traumas in patients admitted to the Emergency Department of a city hospital: effects of age, gender and drinking pattern, *Alcohol and Alcoholism*, 42, 474-479.
188. COOMBER, K., MILLER, P. G., LIVINGSTON, M. & XANTIDIS, L. (2013) Larger regional and rural areas in Victoria, Australia, experience more alcohol-related injury presentations at Emergency Departments, *Journal of Rural Health*, 29, 320-326.
189. AMES, G. M. & GRUBE, J. W. (1999) Alcohol availability and workplace drinking: mixed method analyses, *Journal of Studies on Alcohol*, 60, 383-393.
190. ABBEY, A., SCOTT, R. O., OLIANSKY, D. M., QUINN, B. & ANDRESKI, P. M. (1990) Subjective, social, and physical availability. II. Their simultaneous effects on alcohol consumption, *International Journal of the Addictions*, 25, 1011-1023.
191. STOCKWELL, T. & GRUENEWALD, P. (2003) Controls on physical availability of alcohol, in: Heather, N. & Stockwell, T. (Eds.) *The Essential Handbook of Treatment and Prevention of Alcohol Problems* (Chichester, Wiley and sons).
192. ABBEY, A., SCOTT, R. O. & SMITH, M. J. (1993) Physical, subjective, and social availability: their relationship to alcohol consumption in rural and urban areas, *Addiction*, 88, 489-499.
193. ABBEY, A., SCOTT, R. O., OLIANSKY, D. M., QUINN, B. & ANDRESKI, P. M. (1990) Subjective, social, and physical availability. I. Their interrelationships, *International Journal of the Addictions*, 25, 889-910.
194. GRUENEWALD, P. J. (2007) The spatial ecology of alcohol problems: niche theory and assortative drinking, *Addiction*, 102, 870-878.
195. RONCEK, D. W. & MAIER, P. A. (1991) Bars, blocks and crimes revisited: linking the theory of routine activities to the empiricism of 'hot spots', *Criminology*, 29, 725-753.
196. GROSSMAN, M. (1993) The economic analysis of addictive behavior, in: National Institute of Alcohol Abuse and Alcoholism (Ed.) *Research monograph 25: Economics and the prevention of alcohol-related problems*, pp. 91-123 (Bethesda, MD, US Department of Health and Human Services,).
197. SINGLE, E. (1988) The availability theory of alcohol-related problems, in: Chaudron, C. & Wilkinson, D. (Eds.) *Theories on Alcoholism* (Toronto, Addiction Research Foundation).

198. ANDERSON, P., CHISHOLM, D. & FUHR, D. C. (2009) Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol, *The Lancet*, 373, 2234-2246.
199. TRENO, A. J., ALANIZ, M. L. & GRUENEWALD, P. (2000) The use of drinking places by gender, age and ethnic groups: an analysis of routine drinking activities, *Addiction*, 95, 537-551.
200. SMITH, W. R., FRAZEE, S. G. & DAVISON, E. L. (2000) Furthering the integration of routine activity and social disorganization theories: small units of analysis and the study of street robbery as a diffusion process, *Criminology*, 38, 489-523.
201. FREISTHLER, B. (2004) A spatial analysis of social disorganization, alcohol access, and rates of child maltreatment in neighborhoods, *Children and Youth Services Review*, 26, 807-823.
202. GROSSMAN, M. (1988) Health economics of prevention of alcohol related problems. (Rockville, MD, National Institute on Alcohol Abuse and Alcoholism).
203. COHEN, L. E. & FELSON, M. (1979) Social change and crime rate trends: a routine activity approach, *American Sociological Review*, 44, 588-608.
204. STOCKWELL, T. (1997) Liquor outlets and prevention policy: the need for light in dark corners, *Addiction*, 92, 925-930.
205. STOCKWELL, T., SOMERFORD, P. & LANG, B. (1992) The relationship between license type and alcohol-related problems attributed to licensed premises in Perth, Western Australia, *Journal of Studies on Alcohol*, 53, 495-498.
206. FREISTHLER, B., MIDANIK, L. T. & GRUENEWALD, P. J. (2004) Alcohol outlets and child physical abuse and neglect: applying routine activities theory to the study of child maltreatment, *Journal of Studies on Alcohol*, 65, 586-592.
207. GRUENEWALD, P. J., MITCHELL, P. R. & TRENO, A. J. (1996) Drinking and driving: drinking patterns and drinking problems, *Addiction*, 91, 1637-1649.
208. SCRIBNER, R., MASON, K., THEALL, K. et al. (2008) The contextual role of alcohol outlet density in college drinking, *Journal of Studies on Alcohol and Drugs*, 69, 112-120.
209. ROMAN, C. G. & REID, S. E. (2012) Assessing the relationship between alcohol outlets and domestic violence: routine activities and the neighborhood environment, *Violence and Victims*, 27, 811-828.
210. SAMPSON, R. J. & GROVES, W. B. (1989) Community structure and crime - testing social disorganization theory, *American Journal of Sociology*, 94, 774-802.
211. PETERSON, R. D., KRIVO, L. J. & HARRIS, M. A. (2000) Disadvantage and neighborhood violent crime: do local institutions matter?, *Journal of Research in Crime and Delinquency*, 37, 31-63.
212. ABEL, R. L. (1982) *The Politics of Informal Justice* (New York, Academic Press).
213. RONCEK, D. W. & PRAVATINER, M. A. (1989) Additional evidence that taverns enhance nearby crime, *Sociology and Social Research*, 73, 185-188.
214. PRIDEMORE, W. A. & GRUBESIC, T. H. (2012) Community organisation moderates the effect of alcohol outlet density on violence, *British Journal of Sociology*, 63, 680-703.
215. PRIDEMORE, W. A. & GRUBESIC, T. H. (2013) Alcohol outlets and community levels of interpersonal violence: spatial density, outlet type, and seriousness of assault, *Journal of Research in Crime and Delinquency*, 50, 132-159.
216. MAIMON, D. & BROWNING, C. R. (2012) Underage drinking, alcohol sales and collective efficacy: Informal control and opportunity in the study of alcohol use, *Social Science Research*.
217. CAMPBELL, C. A., HAHN, R. A., ELDER, R. et al. (2009) The effectiveness of limiting alcohol outlet density as a means of reducing excessive alcohol consumption and alcohol-related harms., *American Journal of Preventive Medicine*, 37, 556-569.

218. LIVINGSTON, M., CHIKRITZHS, T. & ROOM, R. (2007) Changing the density of alcohol outlets to reduce alcohol-related problems, *Drug and Alcohol Review*, 26, 557-566.
219. WAGENAAR, A. C., SALOIS, M. J. & KOMRO, K. A. (2009) Effects of beverage alcohol price and tax levels on drinking: a meta-analysis of 1003 estimates from 112 studies, *Addiction*, 104, 179-190.
220. MURRAY, R. K. & RONCEK, D. W. (2008) Measuring diffusion of assaults around bars through radius and adjacency techniques, *Criminal Justice Review*, 33, 199-220.
221. POPOVA, S., GIESBRECHT, N., BEKMURADOV, D. & PATRA, J. (2009) Hours and days of sale and density of alcohol outlets: impacts on alcohol consumption and damage: a systematic review, *Alcohol and Alcoholism*, 44, 500-516.
222. STOCKWELL, T. & CHIKRITZHS, T. (2009) Do relaxed trading hours for bars and clubs mean more relaxed drinking? A review of international research on the impacts of changes to permitted hours of drinking, *Crime Prevention and Community Safety*, 11, 153-170.
223. SMITH, D. I. (1978) Impact on traffic safety of the introduction of Sunday alcohol sales in Perth, Western Australia, *Journal of Studies on Alcohol*, 39, 1302-1304.
224. SMITH, D. I. (1990) Effect on casualty traffic accidents of changing Sunday alcohol sales legislation in Victoria, Australia, *Journal of Drug Issues*, 20, 417-426.
225. CHIKRITZHS, T. & STOCKWELL, T. (2002) The impact of later trading hours for Australian public houses (hotels) on levels of violence, *Journal of Studies on Alcohol*, 63, 591.
226. CHIKRITZHS, T. & STOCKWELL, T. (2006) The impact of later trading hours for hotels on levels of impaired driver road crashes and driver breath alcohol levels, *Addiction*, 101, 1254-1264.
227. CHIKRITZHS, T. & STOCKWELL, T. (2007) The impact of later trading hours for hotels (public houses) on breath alcohol levels of apprehended impaired drivers, *Addiction*, 102, 1609.
228. ROSSOW, I. & NORSTRÖM, T. (2012) The impact of small changes in bar closing hours on violence. The Norwegian experience from 18 cities, *Addiction*, 107, 530-537.
229. BABOR, T., CAETANO, R., CASSWELL, S. et al. (2010) Controlling affordability: pricing and taxation *Alcohol: No Ordinary Commodity*, pp. 109-125 (Oxford, Oxford University Press).
230. TRENO, A. J., PONICKI, W. R., STOCKWELL, T. et al. (2013) Alcohol outlet densities and alcohol price: the British Columbia experiment in the partial privatization of alcohol sales off-premise, *Alcoholism: Clinical and Experimental Research*.
231. BABOR, T. (2010) Alcohol: No Ordinary Commodity - a summary of the second edition, *Addiction*, 105, 769.
232. CARRAGHER, N. & CHALMERS, J. What are the options? Pricing and taxation policy reforms to redress excessive alcohol consumption and related harms in Australia. Sydney: NSW Bureau of Crime Statistics and Research, 2011.
233. WAGENAAR, A. C., TOBLER, A. L. & KOMRO, K. A. (2010) Effects of alcohol tax and price policies on morbidity and mortality: a systematic review, *American Journal of Public Health*, 100, 2270-2278.
234. GALLET, C. A. (2007) The demand for alcohol: a meta-analysis of elasticities, *Australian Journal of Agricultural and Resource Economics*, 51, 121-135.
235. PURSHOUSE, R. C., MEIER, P. S., BRENNAN, A., TAYLOR, K. B. & RAFIA, R. (2010) Estimated effect of alcohol pricing policies on health and health economic outcomes in England: an epidemiological model, *The Lancet*, 375, 1355-1364.
236. STOCKWELL, T., AULD, M. C., ZHAO, J. H. & MARTIN, G. (2012) Does minimum pricing reduce alcohol consumption? The experience of a Canadian province, *Addiction*, 107, 912-920.

237. ZHAO, J., STOCKWELL, T., MARTIN, G. et al. (2013) The relationship between minimum alcohol prices, outlet densities and alcohol-attributable deaths in British Columbia, 2002–09, *Addiction*, 108, 1059-1069.
238. CHIKRITZHS, T., STOCKWELL, T. & PASCAL, R. (2005) The impact of the Northern Territory's Living With Alcohol program, 1992–2002: revisiting the evaluation, *Addiction*, 100, 1625-1636.
239. SYMONS, M., GRAY, D., CHIKRITZHS, T. et al. A longitudinal study of influences on alcohol consumption and related harm in Central Australia: with a particular emphasis on the role of price. Perth, WA: National Drug Research Institute, Curtin University, 2012.
240. LIVINGSTON, M. (2008) Alcohol outlet density and assault: a spatial analysis, *Addiction*, 103, 619-628.
241. CONNOR, J. L., KYPRI, K., BELL, M. L. & COUSINS, K. (2010) Alcohol outlet density, levels of drinking and alcohol-related harm in New Zealand: A national study, *Journal of Epidemiology and Community Health*.
242. STOCKWELL, T., ZHAO, J., MACDONALD, S. et al. (2010) Impact on alcohol-related mortality of a rapid rise in the density of private liquor outlets in British Columbia: a local area multi-level analysis, *Addiction*, 106, 768-776.
243. SMART, R. G. (1977) Relationship of availability of alcoholic beverages to per capita consumption and alcoholism rates, *Journal of Studies on Alcohol*, 38, 891-896.
244. SMART, R. G. & DOCHERTY, D. (1976) Effects of introduction of on-premise drinking on alcohol-related accidents and impaired driving, *Journal of Studies on Alcohol*, 37, 683-686.
245. PARKER, D. A. & WOLZ, M. W. (1979) Alcohol problems and the availability of alcohol, *Alcoholism: Clinical and Experimental Research*, 3, 309-312.
246. PARKER, D. A., HARFORD, T. C. & MALIN, H. J. (1978) Alcohol availability and consumption - empirical assessment, *Alcoholism: Clinical and Experimental Research*, 2, 207-207.
247. WATTS, R. K. & RABOW, J. (1983) Alcohol availability and alcohol-related problems in 312 California cities, *Alcoholism, Clinical and Experimental Research*, 7, 47-58.
248. COLON, I. (1981) Alcohol availability and cirrhosis mortality rates by gender and race, *American Journal of Public Health*, 71, 1325-1328.
249. COLON, I. (1982) The influence of state monopoly on alcohol distribution and the frequency of package stores on single motor vehicle fatalities, *American Journal of Drug and Alcohol Abuse*, 9, 325-332.
250. COLÓN, I. & CUTTER, H. S. G. (1983) The relationship of beer consumption and state alcohol and motor vehicle policies to fatal accidents, *Journal of Safety Research*, 14, 83-89.
251. COLON, I., CUTTER, H. S. G. & JONES, W. C. (1982) Prediction of alcoholism from alcohol availability, alcohol consumption and demographic data, *Journal of Studies on Alcohol*, 43, 1199-1213.
252. LESTER, D. (1993) Restricting the availability of alcohol and rates of personal violence (suicide and homicide), *Drug and Alcohol Dependence*, 31, 215-217.
253. GRUENEWALD, P. J., PONICKI, W. & HOLDER, H. D. (1993) The relationship of outlet densities to alcohol consumption: a time series cross-sectional analysis, *Alcoholism: Clinical and Experimental Research*, 17, 38-47.
254. RUSH, B. R., GLIKSMAN, L. & BROOK, R. (1986) Alcohol availability, alcohol consumption and alcohol-related damage. 1. The distribution of consumption model, *Journal of Studies on Alcohol*, 47, 1-10.
255. GLIKSMAN, L. & RUSH, B. R. (1986) Alcohol availability, alcohol consumption and alcohol-related damage. 2. The role of sociodemographic factors, *Journal of Studies on Alcohol*, 47, 11-18.

256. WILKINSON, J. T. (1987) Reducing drunken driving - which policies are most effective, *Southern Economic Journal*, 54, 322-334.
257. GODFREY, C. (1988) Licensing and the demand for alcohol, *Applied economics*, 20, 1541.
258. MCCORNAC, D. C. & FILANTE, R. W. (1984) The demand for distilled spirits: an empirical investigation, *Journal of Studies on Alcohol*, 45, 176-178.
259. ORNSTEIN, S. I. & HANSSENS, D. M. (1985) Alcohol control laws and the consumption of distilled spirits and beer, *Journal of Consumer Research*, 12, 200-213.
260. VAN OERS, J. A. M. & GARRETSEN, H. F. L. (1993) The geographic relationship between alcohol use, bars, liquor shops and traffic injuries in Rotterdam, *Journal of Studies on Alcohol*, 54, 739-744.
261. GIACOPASSI, D. & WINN, R. (1995) Alcohol availability and alcohol-related crashes: does distance make a difference?, *American Journal of Drug and Alcohol Abuse*, 21, 407-416.
262. SCRIBNER, R. A., MACKINNON, D. P. & DWYER, J. H. (1995) The risk of assaultive violence and alcohol availability in Los Angeles county, *American Journal of Public Health*, 85, 335-340.
263. SCRIBNER, R., COHEN, D., KAPLAN, S. & ALLEN, S. H. (1999) Alcohol availability and homicide in New Orleans: conceptual considerations for small area analysis of the effect of alcohol outlet density, *Journal of Studies on Alcohol*, 60, 310-316.
264. GRUENEWALD, P. J., MILLAR, A. B., TRENO, A. J. et al. (1996) The geography of availability and driving after drinking, *Addiction*, 91, 967-983.
265. JEWELL, R. T. & BROWN, R. W. (1995) Alcohol availability and alcohol-related motor vehicle accidents, *Applied Economics*, 27, 759-765.
266. GRUENEWALD, P. J., MADDEN, P. & JANES, K. (1992) Alcohol availability and the formal power and resources of state alcohol beverage control agencies, *Alcoholism: Clinical and Experimental Research*, 16, 591-597.
267. GRUENEWALD, P. J. & PONICKI, W. (1995) The relationship of the retail availability of alcohol and alcohol sales to alcohol-related traffic crashes, *Accident Analysis and Prevention*, 27, 249-259.
268. RIPPLE, W. J. (1989) *Fundamentals of Geographic Information Systems : a Compendium* (Bethesda, Md., American Congress on Surveying and Mapping).
269. GORMAN, D. M. & SPEER, P. W. (1997) The concentration of liquor outlets in an economically disadvantaged city in the northeastern United States, *Substance Use and Misuse*, 32, 2033-2046.
270. GORMAN, D. M., LABOUVIE, E. W., SPEER, P. W. & SUBAIYA, A. P. (1998) Alcohol availability and domestic violence, *The American Journal of Drug and Alcohol Abuse*, 24, 661-673.
271. GORMAN, D. M., SPEER, P. W., LABOUVIE, E. W. & SUBAIYA, A. P. (1998) Risk of assaultive violence and alcohol availability in New Jersey, *American Journal of Public Health*, 88, 97-100.
272. GORMAN, D. M., SPEER, P. W., GRUENEWALD, P. & LABOUVIE, E. W. (2001) Spatial dynamics of alcohol availability, neighborhood structure and violent crime, *Journal of Studies on Alcohol*, 62, 628-636.
273. ALANIZ, M. L., CARTMILL, R. S. & PARKER, R. N. (1998) Immigrants and violence: the importance of neighborhood context, *Hispanic Journal of Behavioral Sciences*, 20, 155-174.
274. CUNRADI, C., MAIR, C., PONICKI, W. & REMER, L. (2011) Alcohol outlets, neighborhood characteristics, and intimate partner violence: ecological analysis of a Californian city, *Journal of Urban Health*, 88, 191.
275. POLLACK, C. E., CUBBIN, C., AHN, D. & WINKLEBY, M. (2005) Neighbourhood deprivation and alcohol consumption: does the availability of alcohol play a role?, *International Journal of Epidemiology*, 34, 772-780.

276. TRENO, A. J., PONICKI, W., REMER, L. & GRUENEWALD, P. (2008) Alcohol outlets, youth drinking, and self-reported ease of access to alcohol: a constraints and opportunities approach, *Alcoholism: Clinical and Experimental Research*, 32, 1372-1379.
277. KYPRI, K., BELL, M. L., HAY, G. C. & BAXTER, J. (2008) Alcohol outlet density and university student drinking: a national study, *Addiction*, 103, 1131-1138.
278. BRITT, H. R., CARLIN, B. P., TOOMEY, T. L. & WAGENAAR, A. C. (2005) Neighborhood level spatial analysis of the relationship between alcohol outlet density and criminal violence, *Environmental and Ecological Statistics*, 12, 411-426.
279. TOOMEY, T. L., ERICKSON, D. J., CARLIN, B. P. et al. (2012) The association between density of alcohol establishments and violent crime within urban neighborhoods, *Alcoholism: Clinical and Experimental Research*.
280. PEARCE, J., DAY, P. & WITTEN, K. (2008) Neighbourhood provision of food and alcohol retailing and social deprivation in urban New Zealand, *Urban Policy Research*, 26, 213-227.
281. HAY, G. C., WHIGHAM, P. A., KYPRI, K. & LANGLEY, J. D. (2009) Neighbourhood deprivation and access to alcohol outlets: a national study, *Health and Place*, 15, 1086-1093.
282. COSTANZA, S. E., BANKSTON, W. B. & SHIHADEH, E. (2001) Alcohol availability and violent crime rates: a spatial analysis, *Journal of Crime and Justice*, 24, 71-83.
283. TRUONG, K. D. & STURM, R. (2007) Alcohol outlets and problem drinking among adults in California, *Journal of Studies on Alcohol and Drugs*, 68, 923-933.
284. YU, Q., SCRIBNER, R., CARLIN, B. et al. (2008) Multilevel spatio-temporal dual changepoint models for relating alcohol outlet destruction and changes in neighbourhood rates of assaultive violence, *Geospatial Health*, 2, 161-172.
285. REBOUSSIN, B. A., SONG, E. Y. & WOLFSON, M. (2010) The impact of alcohol outlet density on the geographic clustering of underage drinking behaviors within census tracts, *Alcoholism: Clinical and Experimental Research*, 35, 1-9.
286. GRUENEWALD, P. J., FREISTHLER, B., REMER, L., LASCALA, E. A. & TRENO, A. (2006) Ecological models of alcohol outlets and violent assaults: crime potentials and geospatial analysis, *Addiction*, 101, 666-677.
287. ROMLEY, J. A., COHEN, D., RINGEL, J. & STURM, R. (2007) Alcohol and environmental justice: the density of liquor stores and bars in urban neighborhoods in the United States, *Journal of Studies on Alcohol and Drugs*, 68, 48-55.
288. BURGESS, M. & MOFFAT, S. (2011) The association between alcohol outlet density and assaults on and around licensed premises, *Crime and Justice Bulletin*, 1-15.
289. MARKOWITZ, S., CHATTERJI, P. & KAESTNER, R. (2003) Estimating the impact of alcohol policies on youth suicides, *Journal of Mental Health Policy and Economics*, 6, 37-46.
290. WECHSLER, H., LEE, J. E., HALL, J., WAGENAAR, A. C. & LEE, H. (2002) Secondhand effects of student alcohol use reported by neighbors of colleges: the role of alcohol outlets, *Social Science and Medicine*, 55, 425-435.
291. WILKINSON, C. & LIVINGSTON, M. (2011) Distances to on- and off-premise alcohol outlets and experiences of alcohol-related amenity problems, *Drug and Alcohol Review*.
292. LASCALA, E. A., GERBER, D. & GRUENEWALD, P. (2000) Demographic and environmental correlates of pedestrian injury collisions: a spatial analysis, *Accident Analysis and Prevention*, 32, 651-658.
293. LASCALA, E. A., JOHNSON, F. W. & GRUENEWALD, P. (2001) Neighborhood characteristics of alcohol-related pedestrian injury collisions: a geostatistical analysis, *Prevention Science*, 2, 123-134.
294. GRUENEWALD, P. J., JOHNSON, F. W. & TRENO, A. (2002) Outlets, drinking and driving: a multilevel analysis of availability, *Journal of Studies on Alcohol*, 63, 460-468.

295. BAUGHMAN, R., CONLIN, M., DICKERT-CONLIN, S. & PEPPER, J. (2001) Slippery when wet: the effects of local alcohol access laws on highway safety, *Journal of Health Economics*, 20, 1089-1096.
296. ESCOBEDO, L. G. & ORTIZ, M. (2002) The relationship between liquor outlet density and injury and violence in New Mexico, *Accident Analysis and Prevention*, 34, 689-694.
297. MCCARTHY, P. (2003) Alcohol-related crashes and alcohol availability in grass-roots communities, *Applied Economics*, 35, 1331-1338.
298. MCCARTHY, P. S. (2005) Alcohol, public policy, and highway crashes: a time-series analysis of older-driver safety, *Journal of Transport Economics and Policy*, 39, 109-125.
299. MELIKER, J., MAIO, R., ZIMMERMAN, M. et al. (2004) Spatial analysis of alcohol-related motor vehicle crashes in southeastern Michigan, *Accident Analysis and Prevention*, 36, 1129-1135.
300. MOSKOWITZ, H. & FIORENTINO, D. A review of the literature on the effects of low doses of alcohol on driving-related skills. National Highway Traffic Safety Administration, 2000 Contract No.: DOT HS 809 028
301. GRUENEWALD, P. J. (2010) Drinking, driving, and crashing: a traffic-flow model of alcohol-related motor vehicle accidents, *Journal of Studies on Alcohol and Drugs*, 71, 237-248.
302. CAMERON, M. P., COCHRANE, W., MCNEILL, K. et al. (2012) Alcohol outlet density is related to police events and motor vehicle accidents in Manukau City, New Zealand, *Australian and New Zealand Journal of Public Health*, 36, 537-542.
303. GYIMAH-BREMPONG, K. (2001) Alcohol availability and crime: evidence from census tract data, *Southern Economic Journal*, 68, 2-21.
304. GYIMAH-BREMPONG, K. & RACINE, J. (2006) Alcohol availability and crime: a robust approach, *Applied Economics*, 38, 1293-1307.
305. GYIMAH-BREMPONG, K. (2006) Neighborhood income, alcohol availability, and crime rates, *Review of Black Political Economy*, 33, 21-44+4-5.
306. NIELSEN, A. L. & MARTINEZ, J. R. (2003) Reassessing the alcohol-violence linkage: results from a multiethnic city, *Justice Quarterly*, 20, 445-469.
307. NIELSEN, A. L., MARTINEZ JR, R. & LEE, M. T. (2005) Alcohol, ethnicity, and violence: the role of alcohol availability for Latino and black aggravated assaults and robberies, *Sociological Quarterly*, 46, 479-502.
308. LARANJEIRA, R. & HINKLY, D. (2002) Evaluation of alcohol outlet density and its relation with violence, *Rev Salud Publica*, 36, 455-461.
309. REID, R. J., HUGHEY, J. & PETERSON, N. A. (2003) Generalizing the alcohol outlet-assaultive violence link: evidence from a U.S. midwestern city, *Substance Use and Misuse*, 38, 1971-1982.
310. LIPTON, R. & GRUENEWALD, P. (2002) The spatial dynamics of violence and alcohol outlets, *Journal of Studies on Alcohol*, 63, 187-195.
311. GORMAN, D. M., ZHU, L. & HOREL, S. (2005) Drug 'hot-spots', alcohol availability and violence, *Drug and Alcohol Review*, 24, 507-513.
312. YU, Q., LI, B. & SCRIBNER, R. (2009) Hierarchical additive modeling of nonlinear association with spatial correlations - an application to relate alcohol outlet density and neighborhood assault rates, *Statistics in Medicine*, 28, 1896-1912.
313. BRANAS, C. C., ELLIOT, M. R., RICHMOND, R. S., CULHANE, D. P. & WIEBE, D. J. (2009) Alcohol consumption, alcohol outlets and the risk of being assaulted with a gun, *Alcoholism: Clinical and Experimental Research*, 33, 906-915.
314. FRANKLIN, F. A., LAVEIST, T. A., WEBSTER, D. W. & PAN, W. K. (2010) Alcohol outlets and violent crime in Washington D.C., *Western Journal of Emergency Medicine*, 11.
315. GRUBESIC, T. H. & PRIDEMORE, W. A. (2011) Alcohol outlets and clusters of violence, *International Journal of Health Geographics*, 30.

316. SCHWESTER, R. (2010) Alcohol outlet densities, crime and population restrictions on alcohol licenses, *Public Administration and Management*, 15, 365-380.
317. GUO, Q., SHIH, M., ANGELESCU, A. et al. (2011) Alcohol outlet density and its associations with alcohol related harms in Los Angeles County, *Annals of Behavioral Medicine*, 41, S245-S245.
318. DAY, P., BREETZKE, G., KINGHAM, S. & CAMPBELL, M. (2012) Close proximity to alcohol outlets is associated with increased serious violent crime in New Zealand, *Australian and New Zealand Journal of Public Health*, 36, 48.
319. MAIR, C., GRUENEWALD, P. J., PONICKI, W. R. & REMER, L. (2013) Varying impacts of alcohol outlet densities on violent assaults: explaining differences across neighborhoods, *Journal of Studies on Alcohol and Drugs*, 74, 50-58.
320. WEITZMAN, E. R., FOLKMAN, A., FOLKMAN, K. L. & WECHSLER, H. (2003) The relationship of alcohol outlet density to heavy and frequent drinking and drinking-related problems among college students at eight universities, *Health and Place*, 9, 1-6.
321. TRENO, A. J., GRUBE, J. W. & MARTIN, S. E. (2003) Alcohol availability as a predictor of youth drinking and driving: a hierarchical analysis of survey and archival data, *Alcoholism: Clinical and Experimental Research*, 27, 835-840.
322. SMART, R. G., ADLAF, E. M. & WALSH, G. W. (1996) Procurement of alcohol and underage drinking among adolescents in Ontario, *Journal of Studies on Alcohol*, 57, 419-424.
323. WAGENAAR, A. C. & HOLDER, H. D. (1996) The scientific process works: seven replications now show significant wine sales increases after privatization, *Journal of Studies on Alcohol*, 57, 575-576.
324. CHEN, M. J., GRUENEWALD, P. & REMER, L. (2009) Does alcohol outlet density affect youth access to alcohol?, *Journal of Adolescent Health*, 44, 582-589.
325. KUNTSCHE, E., KUENDIG, H. & GMEL, G. (2008) Alcohol outlet density, perceived availability and adolescent alcohol use: a multilevel structural equation model, *Journal of Epidemiology and Community Health*, 62, 811-816.
326. STANLEY, L. R., HENRY, K. L. & SWAIM, R. C. (2011) Physical, social, and perceived availabilities of alcohol and last month alcohol use in rural and small urban communities, *Journal of Youth and Adolescence*, 40, 1203-1214.
327. TRUONG, K. D. & STURM, R. (2009) Alcohol environments and disparities in exposure associated with adolescent drinking in California, *American Journal of Public Health*, 99, 264-270.
328. HUCKLE, T., HUAKAU, J., SWEETSUR, P., HUISMAN, O. & CASSWELL, S. (2008) Density of alcohol outlets and teenage drinking: Living in an alcogenic environment is associated with higher consumption in a metropolitan setting, *Addiction*, 103, 1614-1621.
329. PASCH, K. E., HEARST, M. O., NELSON, M. C., FORSYTH, A. & LYTLE, L. A. (2009) Alcohol outlets and youth alcohol use: exposure in suburban areas, *Health and Place*, 15, 642-646.
330. TOBLER, A. L., KOMRO, K. A. & MALDONADO-MOLINA, M. M. (2009) Relationship between neighborhood context, family management practices and alcohol use among urban, multi-ethnic, young adolescents, *Prevention Science*, 10, 313-324.
331. GRUENEWALD, P., FREISTHLER, B., REMER, L. et al. (2010) Ecological associations of alcohol outlets with underage and young adult injuries, *Alcoholism: Clinical and Experimental Research*, 34, 519-527.
332. PARKER, R. N., WILLIAMS, K. R., MCCAFFREE, K. J. et al. (2011) Alcohol availability and youth homicide in the 91 largest US cities, 1984-2006, *Drug and Alcohol Review*, 30, 505-514.
333. PASCHALL, M. J., GRUBE, J. W., THOMAS, S., CANNON, C. & TREFFERS, R. (2012) Relationships between local enforcement, alcohol availability, drinking norms, and

adolescent alcohol use in 50 California cities, *Journal of Studies on Alcohol and Drugs*, 73, 657.
334. YOUNG, R., MACDONALD, L. & ELLAWAY, A. (2013) Associations between proximity and density of local alcohol outlets and alcohol use among Scottish adolescents, *Health and Place*, 19, 124-130.
335. MARKOWITZ, S. & GROSSMAN, M. (1998) Alcohol regulation and domestic violence towards children, *Contemporary Economic Policy*, 16, 309-320.
336. FREISTHLER, B., NEEDELL, B. & GRUENEWALD, P. J. (2005) Is the physical availability of alcohol and illicit drugs related to neighborhood rates of child maltreatment?, *Child Abuse and Neglect*, 29, 1049-1060.
337. FREISTHLER, B. & WEISS, R. E. (2008) Using Bayesian space-time models to understand the substance use environment and risk for being referred to child protective services, *Substance Use and Misuse*, 43, 239-251.
338. FREISTHLER, B., BYRNES, H. F. & GRUENEWALD, P. J. (2009) Alcohol outlet density, parental monitoring, and adolescent deviance: a multilevel analysis, *Children and Youth Services Review*, 31, 325-330.
339. FREISTHLER, B. & GRUENEWALD, P. J. (2013) Where the individual meets the ecological: a study of parent drinking patterns, alcohol outlets, and child physical abuse, *Alcoholism: Clinical and Experimental Research*.
340. LIVINGSTON, M. (2010) The ecology of domestic violence: the role of alcohol outlet density, *Geospatial Health*, 5, 139-149.
341. LIVINGSTON, M. (2011) A longitudinal analysis of alcohol outlet density and domestic violence, *Addiction*, 106, 919-925.
342. MCKINNEY, C. M., CAETANO, R., HARRIS, T. R. & EBAMA, M. S. (2009) Alcohol availability and intimate partner violence among US couples, *Alcoholism: Clinical and Experimental Research*, 33, 169-176.
343. WALLER, M. W., IRITANI, B. W., CHRIST, S. L. et al. (2012) Relationships among alcohol outlet density, alcohol use, and intimate partner violence victimization among young women in the United States, *Journal of Interpersonal Violence*, 27, 2062-2086.
344. WALLER, M. W., IRITANI, B. W., FLEWELLING, R. L. et al. (2012) Violence victimization of young men in heterosexual relationships: does alcohol outlet density influence outcomes?, *Violence and Victims*, 27, 527-547.
345. MCKINNEY, C., CHARTIER, K. G., CAETANO, R. & HARRIS, T. R. (2012) Alcohol Availability and Neighborhood Poverty and Their Relationship to Binge Drinking and Related Problems Among Drinkers in Committed Relationships, *Journal of Interpersonal Violence*, 27, 2703.
346. JOHNSON, F. W., GRUENEWALD, P. & REMER, L. (2009) Suicide and alcohol: do outlets play a role?, *Alcoholism: Clinical and Experimental Research*, 33, 2124.
347. BRANAS, C., RICHMOND, T., HAVE, T. & WIEBE, D. (2011) Acute alcohol consumption, alcohol outlets, and gun suicide, *Substance Use and Misuse*, 46, 1592.
348. TRENO, A. J., GRUENEWALD, P. & JOHNSON, F. W. (2001) Alcohol availability and injury: the role of local outlet densities, *Alcoholism: Clinical and Experimental Research*, 25, 1467-1471.
349. SCRIBNER, R. A., COHEN, D. & FISHER, W. (2000) Evidence of a structural effect for alcohol outlet density: a multilevel analysis, *Alcoholism: Clinical and Experimental Research*, 24, 188-195.
350. US DEPARTMENT OF HEALTH AND HUMAN SERVICES. 10th special report to the U.S. Congress on alcohol and health. Bethesda, MA: National Institute on Alcohol Abuse and Alcoholism, 2000 Contract No.: National Institutes of Health, REP023.
351. BLUTHENTHAL, R. N., COHEN, D. & SCRIBNER, R. (2008) Alcohol availability and neighborhood characteristics in Los Angeles, California and Southern Louisiana, *Journal of Urban Health*, 85, 191-205.

352. LANG, B. & STOCKWELL, T. (1991) Drinking locations of drink-drivers: a comparative analysis of accident and nonaccident cases, *Accident Analysis and Prevention*, 23, 573-584.
353. STOCKWELL, T., LANG, E. & RYDON, P. (1993) High-risk drinking settings - the association of serving and promotional practices with harmful drinking, *Addiction*, 88, 1519-1526.
354. LIVINGSTON, M. (2008) Recent trends in risky alcohol consumption and related harm among young people in Victoria, Australia, *Australian and New Zealand Journal of Public Health*, 32, 266-271.
355. LIVINGSTON, M. (2011) Alcohol outlet density and harm: comparing the impacts on violence and chronic harms, *Drug and Alcohol Review*, 30, 515-523.
356. KAVANAGH, A. M., KELLY, M. T., KRNJACKI, L. et al. (2011) Access to alcohol outlets and harmful alcohol consumption: a multi-level study in Melbourne, Australia, *Addiction*.
357. (2009) Australian guidelines to reduce health risks from drinking alcohol, in: National Health and Medical Research Institute (Ed.) (Canberra, Commonwealth of Australia).
358. PEREIRA, G., WOOD, L., FOSTER, S. & HAGGAR, F. (2013) Access to alcohol outlets, alcohol consumption and mental health, *PLoS ONE*, 8, e53461.
359. XIE, X., MANN, R. E. & SMART, R. G. (2000) The direct and indirect relationships between alcohol prevention measures and alcoholic liver cirrhosis mortality, *Journal of Studies on Alcohol*, 61, 499-506.
360. SCHONLAU, M. (2008) Alcohol outlet density and alcohol consumption in Los Angeles county and southern Louisiana, *Geospatial Health*, 3, 91-101.
361. PICONE, G., MACDOUGALD, J., SLOAN, F., PLATT, A. & KERTESZ, S. (2010) The effects of residential proximity to bars on alcohol consumption, *International Journal of Health Care Finance and Economics*, 10, 347-367.
362. GRUENEWALD, P. J. & PONICKI, W. (1995) The relationship of alcohol sales to cirrhosis mortality, *Journal of Studies on Alcohol*, 56, 635-641.
363. GRUENEWALD, P. J., PONICKI, W. R. & MITCHELL, P. R. (1995) Suicide rates and alcohol consumption in the United States, 1970-89, *Addiction*, 90, 1063-1075.
364. GRUENEWALD, P. J., STOCKWELL, T., BEEL, A. & DYSKIN, E. V. (1999) Beverage sales and drinking and driving: the role of on-premise drinking places, *Journal of Studies on Alcohol*, 60, 47-53.
365. RAY, J. G., MOINEDDIN, R., BELL, C. M. et al. (2008) Alcohol sales and risk of serious assault, *PLoS Medicine*, 5, e104.
366. NORSTRÖM, T. & RAZVODOVSKY, Y. (2010) Per capita alcohol consumption and alcohol-related harm in Belarus, 1970-2005, *European Journal of Public Health*, 20, 564-568.
367. KERR, W., KARRIKER-JAFFE, K., SUBBARAMAN, M. & YE, Y. (2011) Per capita alcohol consumption and ischemic heart disease mortality in a panel of US states from 1950 to 2002, *Addiction*, 106, 313.
368. STOCKWELL, T., SOMERFORD, P. & LANG, B. (1991) The measurement of harmful outcomes following drinking on licensed premises, *Drug and Alcohol Review*, 10, 99-106.
369. History: National Drug Research Institute. Perth [cited 2012 6 March]; Available from: http://ndri.curtin.edu.au/about/index.cfm.
370. MIDFORD, R., MASTERS, L., PHILLIPS, M. et al. (1998) Alcohol consumption and injury in Western Australia: a spatial correlation analysis using geographic information systems, *Australian and New Zealand Journal of Public Health*, 22, 80-85.
371. YOUNG, D. J., STOCKWELL, T. R., CHERPITEL, D. J. et al. Emergency Room injury presentations as a surrogate measure of alcohol-related problems in the community:

a multilevel analysis of an international study. Perth, Australia: National Drug Research Institute, Curtin University of Technology, 2004 March 2004. Report No.
372. STEVENSON, R. J., LIND, B. & WEATHERBURN, D. (1999) Property damage and public disorder: their relationship with sales of alcohol in New South Wales, Australia, *Drug and Alcohol Dependence*, 54, 163-170.
373. STOCKWELL, T., ZHAO, J., CHIKRITZHS, T. & GREENFIELD, T. K. (2008) What did you drink yesterday? Public health relevance of a recent recall method used in the 2004 Australian National Drug Strategy Household Survey, *Addiction*, 103, 919-928.
374. CATALANO, P., CHIKRITZHS, T., STOCKWELL, T. et al. Trends in per capita alcohol consumption in Australia, 1990/91-1998/99. Perth, WA: National Drug Research Institute Monograph no. 4, 2001 May. Report No.
375. LOXLEY, W., CHIKRITZHS, T. & PASCAL, R. National alcohol sales data project stage one, final report 2009. Perth: Drug and Alcohol Office WA, National Drug Research Institute, Curtin University of Technology, 2010 October. Report No.
376. HALL, W. D., CHIKRITZHS, T., D'ABBS, P. & ROOM, R. (2008) Alcohol sales data are essential for good public policies towards alcohol, *Medical Journal of Australia*, 189, 188-189.
377. BOWERS, K. J. & JOHNSON, S. D. (2003) Measuring the geographical displacement and diffusion of benefit effects of crime prevention activity, *Journal of Quantitative Criminology*, 19, 275-301.
378. GROFF, E. (2011) Exploring 'near': characterizing the spatial extent of drinking place influence on crime, *Australian and New Zealand Journal of Criminology*, 44, 156-179.
379. ESRI (2012) ArcGIS Desktop: Release 10.1 (Redlands, CA, Environmental Systems Research Institute).
380. RATCLIFFE, J. H. (2012) The spatial extent of criminogenic places: a changepoint regression of violence around bars, *Geographical Analysis*, 44, 302-320.
381. KIRKWOOD, B. R. & STERNE, J. A. C. (2003) *Essential Medical Statistics* (Blackwell Science).
382. HILBE, J. (2008) *Negative Binomial Regression* (Cambridge, United Kingdom, Cambridge University Press).
383. ROTHMAN, K. J., GREENLAND, S. & NASH, T. L. L. (2008) *Modern Epidemiology* (Philidelphia, Lippincott Williams & Wilkins).
384. BUIS, M. (2010) Re: xtnbreg pre and post estimation, in: Jabr, W. M. (Ed.) (Statalist).
385. GREENLAND, S. (2000) When should epidemiologic regressions use random coefficients?, *Biometrics*, 56, 915-921.
386. ELHORST, J. P. (2010) MATLAB software for spatial panels *IVth World Conference of the Spatial Econometrics Association* (Chicago).
387. TOBLER, W. R. (1970) A computer movie simulating urban growth in the Detroit region, *Economic Geography*, 46, 234-240.
388. CHARLTON, M. & FOTHERINGHAM, A. S. Geographically weighted regression: white paper. Maynooth, Ireland: National University of Ireland, Geocomputation, N. C. f.; 2009 3 March. Report No.
389. ESRI. Geographically weighted regression (GWR) (spatial statistics). 2013 [updated 18 April 2013; cited 2013 9 May]; Available from: http://resources.arcgis.com/en/help/main/10.1/index.html#//005p00000021000000.
390. GRIFFITH, D. A. (2005) Spatial autocorrelation (Syracuse University).
391. GETIS, A. (2008) A history of the concept of spatial autocorrelation: a geographer's perspective, *Geographical Analysis*, 40, 297-309.
392. GOODCHILD, M. F. (2009) What problem: spatial autocorrelation and geographic information science, *Geographical Analysis*, 41, 411-417.

393. GRUENEWALD, P. J., MILLAR, A. B. & ROEPER, P. (1996) Access to alcohol: geography and prevention for local communities, *Alcohol Health and Research World*, 20, 244-251.
394. VITON, P. A. (2010) Notes on spatial econometric models, pp. 23 (Ohio State University).
395. ANSELIN, L. (1988) *Spatial Econometrics : Methods and Models* (Dordecht, Netherlands, Kluwer Academic Publishers).
396. ABS (2009) Australian Standard Geographical Classification (ASGC): Western Australia maps (Commonwealth of Australia).
397. ABS (2007) 2905.0.55.001 - ABS Postal Area Concordances: August 2006.
398. (2010) Perth and surrounds 2010 street directory (Osborne Park, UBD).
399. WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY. Landgate. 2013; Available from: http://www.landgate.wa.gov.au/corporate.nsf/web/About+Us.
400. ABS. 2011 Census Quick Stats: Greater Perth 2012 [cited 2013 14 February]; Available from: http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/5GPER?opendocument&navpos=220.
401. ABS (2002) 2001 Census Community Profile Series : Perth (Statistical Division).
402. Data Linkage Western Australia. Perth [updated 24 November 2010; cited 2011 30 March]; Available from: http://www.datalinkage-wa.org/.
403. HOLMAN, C. D. J., ROUSE, I. L. & HOBBS, M. S. T. (1999) Population-based linkage of health records in Western Australia: development of a health services research linked database, *Australian and New Zealand Journal of Public Health*, 23, 453-459.
404. Emergency Management (EDIS). CSC; 2013 [cited 2013 11 February]; Available from: http://www.isofthealth.com/en-AU/Products/Hospital/Emergency%20Management.aspx.
405. Module 3 variable lists: Emergency data. Perth: Department of Health, Government of Western Australia.
406. CODDE, J. P., BOWEN, S. & LLOYD, E. Analysis of demand and utilisation of metropolitan Emergency Departments in Western Australia. Perth, Australia: Health Reform Implementation Taskforce, Department of Health, 2005.
407. CODDE, J. P. (2012) Re: query re EDIS (Perth).
408. INFORMATION MANAGEMENT AND REPORTING DIRECTORATE. Emergency Department Data Collection data dictionary: version 1.1. Perth: Department of Health, Western Australia, 2007.
409. HOLMAN, C. D. J. (2009) Attendances at Perth Metropolitan Hospital Emergency Departments attributable to tobacco in 2008, in: Daube, M. (Ed.).
410. STATACORP (2011) Stata Statistical Software: release 12 (College Station, TX, StataCorp LP.).
411. BRADLEY, C. & HARRISON, J. Hospital separations due to injury and poisoning, Australia 2004–05. Adelaide: Australian Institute of Health and Welfare, 2008 November. Report No.: 47.
412. ABS. 1216.0 - Australian Standard Geographical Classification (ASGC). Appendix Two: Changes to Geographic Areas 2006-2011. 2011.
413. Curtin FM. Perth2011 [cited 2012 6 January]; Available from: http://www.curtinfm.com.au/.
414. FEDER, M. (2008) Test-retest reliability, in: Lavrakas, P. (Ed.) *Encylopaedia of Survey Research Methods*, pp. 888-889 (Thousand Oaks, Sage).
415. PUREPROFILE (2010) Pureprofile global panelbook.
416. AUSTRALIAN INSTITUTE OF HEALTH AND WELFARE. 2007 National Drug Strategy Household Survey. Canberra: Australian Government Department of Health and Ageing; 2009; Available from: http://www.ada.edu.au/social-science/01139.
417. FARRELL, D. & PETERSEN, J. C. (2010) The growth of internet research methods and the reluctant sociologist, *Sociological Inquiry*, 80, 114-125.

418. KRAUT, R., OLSON, J., BANAJI, M. et al. (2004) Psychological research online: report of the Board of Scientific Affairs' Advisory Group on the Conduct of Research on the Internet, *American Psychologist*, 59, 105-117.
419. WRIGHT, K. B. (2005) Researching internet-based populations: advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services, *Journal of Computer-Mediated Communication*, 10.
420. BRIGHAM, J., LESSOV-SCHLAGGAR, C. N., JAVITZ, H. S. et al. (2009) Test-retest reliability of web-based retrospective self-report of tobacco exposure and risk, *Journal of Medical Internet Research*, 11.
421. BIRNBAUM, M. H. (2004) Human research and data collection via the internet, pp. 803-832.
422. Pureprofile for researchers. [cited 2011 31 March]; Available from: http://researchers.pureprofile.com/.
423. ABS (2008) 2033.0.55.001 - Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia , 2006.
424. MICROSOFT (2009) Microsoft Excel (Redmond, Washington).
425. ABS. Australian Bureau of Statistics. Canberra; Available from: http://www.abs.gov.au/.
426. CODDE, J. (2009) Rates calculator, in: Health, W. D. o. (Ed.) (Epidemiology and GIS Branch, Department of Health, WA).
427. ABS (2007) 2923.0.30.001 - Census of Population and Housing: Census Geographic Areas Digital Boundaries, Australia, 2006
428. CATALANO, P. (2012) Personal interview.
429. ESRI. What is a map projection? : Environmental Systems Research Institute, Inc.; 2010 [updated 16 June 2010; cited 2012 7 May]; Available from: http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?topicname=what_is_a_map_projection?
430. XIA, C. (2012) Telephone conversation.
431. HEYWOOD, D. I., CORNELIUS, S. & CARVER, S. (1998) *An Introduction to Geographical Information Systems* (Addison Wesley Longman).
432. DISTILLED SPIRITS INDUSTRY COUNCIL OF AUSTRALIA 2006. Alcohol tax in Australia. 2006.
433. ABS (2001) 2033.0.55.001 - Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2001
434. ABS (2011) 3218.0 - Australia: Age Structure in 2006: Estimated Resident Population (Canberra).
435. LUK, J., LLOYD, B. & YOO, Y. New speed-flow curves for Perth. Vermont South: ARRB Group Ltd, 2009 Contract No.: ARR 374.
436. LUK, J. (2012) Email communication about process of developing zones from Perth CBD.
437. MULLAN, N. (2012) Telephone conversation.
438. Main Roads Western Australia. 2013 [cited 2013]; Available from: http://www.mainroads.wa.gov.au/Pages/Welcome.aspx.
439. ESRI. Spatial weights: ArcGIS help 10.1. 2013 [updated 18 April 2013]; Available from: http://resources.arcgis.com/en/help/main/10.1/index.html#//005p00000035000000.
440. ESRI. Modeling spatial relationships. 2013 [updated 18 April 2013]; Available from: http://resources.arcgis.com/en/help/main/10.1/index.html#//005p00000005000000.
441. PONICKI, W. R., GRUENEWALD, P. J. & REMER, L. G. (2013) Spatial panel analyses of alcohol outlets and motor vehicle crashes in California: 1999-2008, *Accident Analysis and Prevention*, 55, 135-143.
442. (2007) National Statement on Ethical Conduct in Human Research (Canberra, Australian Government).

443. US CENSUS BUREAU (2000) Table DP-1: profile of general demographic characteristics: 2000. Geographic area: United States (Washington D.C.).
444. ABS (2007) 20680 - Age by Sex - Australia: 2006 Census Tables (Canberra).
445. ABS (2011) 3218.0 - Regional Population Growth, Australia, 2009-10.
446. STEEN, K. & HUNSKAAR, S. (2004) Gender and physical violence, *Social Science and Medicine*, 59, 567-571.
447. COHEN, J. (1960) A coefficient of agreement for nominal scales, *Educational and Psychological Measurement*, 20, 37-46.
448. STATACORP (2011) *Stata 12 Base Reference Manual* (College Station, TX, Stata Press).
449. LANDIS, J. R. & KOCH, G. G. (1977) The measurement of observer agreement for categorical data, *Biometrics*, 33, 159-174.
450. AUSTRALIAN INSTITUTE FOR HEALTH AND WELFARE. National Drugs Strategy Household Survey 2012 [cited 2013 25 February]; Available from: http://www.aihw.gov.au/national-drugs-strategy-household-surveys/.
451. AUSTRALIAN INSTITUTE OF HEALTH AND WELFARE. 2010 National Drug Strategy Household Survey. Canberra: Australian Government Department of Health and Ageing; 2011 [cited 2013 13 November]; Available from: http://www.ada.edu.au/social-science/01237.
452. PINK, B. 2039.0.55.001 Socio-Economic Indexes for Areas (SEIFA) -Technical Paper 2006. Canberra: Australian Bureau of Statistics, 2008.
453. PAGANO, M. & GAUVREAU, K. (2000) *Principles of Biostatistics* (Pacific Grove, CA, Duxbury).
454. AUSTRALIA, S. G. O. W. Directions 2031 and beyond. Perth: 2010 August. Report No.
455. CHERPITEL, C. J. & YE, Y. (2010) Alcohol and violence-related injuries among Emergency Room patients in an international perspective, *Journal of the American Psychiatric Nurses Association*, 16, 227-235.
456. ABS. Postal Areas. 2012 [updated 27 July 2012; cited 2014 5 January]; Available from: http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/736A18F4CBF81595CA2578D40012CF51?opendocument.
457. VOAS, R. B. & FELL, J. C. (2010) Preventing alcohol-related problems through health policy research, *Alcohol Research and Health*, 33, 18-28.
458. KUENDIG, H., HASSELBERG, M., GMEL, G., DAEPPEN, J. B. & LAFLAMME, L. (2009) Acute and usual drinking among emergency trauma patients: a study on alcohol consumption and injury patterns, *Injury Prevention*, 15, 270-274.
459. JONES, S. C., BARRIE, L., ROBINSON, L., ALLSOP, S. & CHIKRITZHS, T. (2012) Point-of-sale alcohol promotions in the Perth and Sydney metropolitan areas, *Drug Alcohol Rev*, 31, 803-8.
460. BORKENSTEIN, R. F., CROWTHER, R. F. & SHUMATE, R. P. (1974) The role of the drinking driver in traffic accidents (the Grand Rapids study), *Blutalkohol*, 11.
461. JERGA, J. (2010) Northbridge tagged Perth's most violent *Sydney Morning Herald* (Sydney).
462. HALONEN, J. I., KIVIMÄKI, M., VIRTANEN, M. et al. (2013) Living in proximity of a bar and risky alcohol behaviours: a longitudinal study, *Addiction*, 108, 320-328.
463. ABS. 2901.0 - Census Dictionary, 2006. 2006 [updated 20 May 2011; cited 2014 26 February]; Available from: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Previousproducts/413876F3BAE9CC70CA25720A000C428B?opendocument.
464. DEPARTMENT OF RACING GAMING AND LIQUOR. Overview of all licence categories. 2014; Available from: http://www.rgl.wa.gov.au/ResourceFiles/Publications/Overview_all_licence_types.pdf.

465. Lapa Brazilian Barbecue Restaurant drinks list: Subiaco. 2014; Available from: file:///C:/Users/15291420/Downloads/SUBI%20WINE%20LIST%20%20november%207%202013.pdf.
466. Lapa Brazilian Barbecue Restaurant drinks list: Armadale. 2014 [cited 2014 27 February]; Available from: file:///C:/Users/15291420/Downloads/ArmadaleDrinkList.pdf.
467. VOS, T., BARKER, B., STANLEY, L. & LOPEZ, A. The burden of disease and injury in Aboriginal and Torres Strait Islander peoples 2003. Brisbane: Centre for Burden of Disease and Cost-Effectiveness, University of Queensland, 2007.
468. WILSON, M., STEARNE, A., GRAY, D. & SAGGERS, S. (2010) The harmful use of alcohol amongst Indigenous Australians *Australian Indigenous Healthinfonet*.
469. JOBES, P. C., BARCLAY, E., WEINAND, H. & DONNERMEYER, J. F. (2004) A structural analysis of social disorganisation and crime in rural communities in Australia, *Australian and New Zealand Journal of Criminology*, 37, 114-140.
470. SNOWBALL, L. & WEATHERBURN, D. (2008) Theories of Indigenous violence: a preliminary empirical assessment, *Australian and New Zealand Journal of Criminology*, 41, 216-235.
471. DIETZE, P. M., JOLLEY, D. J., CHIKRITZHS, T. N. et al. (2009) Income inequality and alcohol attributable harm in Australia, *BMC Public Health*, 9, 70.
472. CUBBIN, C., LECLERE, F. B. & SMITH, G. S. (2000) Socioeconomic status and injury mortality: individual and neighbourhood determinants, *Journal of Epidemiology and Community Health*, 54, 517-524.
473. LAFLAMME, L., BURROW, S. & HASSELBERG, M. Socio-economic differences in injury risks. Copenhagen: World Health Organisation, 2009.
474. GISKES, K., TURRELL, G., BENTLEY, R. & KAVANAGH, A. (2011) Individual and household-level socioeconomic position is associated with harmful alcohol consumption behaviours among adults, *Australian and New Zealand Journal of Public Health*, 35, 270-277.
475. FONE, D. L., FAREWELL, D. M., WHITE, J., LYONS, R. A. & DUNSTAN, F. D. (2013) Socioeconomic patterning of excess alcohol consumption and binge drinking: a cross-sectional study of multilevel associations with neighbourhood deprivation, *BMJ Open*, 3.
476. STOKES, M., ASHBY, K. & CLAPPERTON, A. The effect of socio-economic status on injury among Victorians. Melbourne: Victorian Injury Surveillance and Applied Research System (VISAR), 2002 Summer 2001/02. Report No.
477. LIVINGSTON, M. (2012) The social gradient of alcohol availability in Victoria, Australia, *Australian and New Zealand Journal of Public Health*, 36, 41.
478. HUMENSKY, J. L. (2010) Are adolescents with high socioeconomic status more likely to engage in alcohol and illicit drug use in early adulthood?, *Substance Abuse Treatment, Prevention, and Policy*, 5, 1-10.
479. STOCKWELL, T., CHIKRITZHS, T., HENDRIE, D. et al. (2001) The public health and safety benefits of the Northern Territory's Living With Alcohol programme., *Drug and Alcohol Review*, 167-180.
480. DAUBE, M. Review of the Liquor Control Act 1988 . Submission by the McCusker Centre for Action on Alcohol and Youth Perth, Australia: McCusker Centre for Action on Alcohol and Youth, Curtin University, 2013.
481. BALLESTEROS, J., DUFFY, J. C., QUEREJETA, I., ARIÑO, J. & GONZÁLEZ-PINTO, A. (2004) Efficacy of brief interventions for hazardous drinkers in primary care: systematic review and meta-analyses, *Alcoholism: Clinical and Experimental Research*, 28, 608-618.
482. KANER, E. F. S., BEYER, F., DICKINSON, H. O. et al. (2007) Effectiveness of brief alcohol interventions in primary care populations, *Cochrane Database of Systematic Reviews*.

10 Appendices

10.1 Ethics permission

Curtin University

Memorandum

To	Associate Professor Tanya Chikritzhs, National Drug Research Institute
From	Assoc/Prof Stephan Millett, Chair, Human Research Ethics Committee
Subject	Protocol Approval **HR 110/2011**
Date	14 October 2011
Copy	Mrs Michelle Hobday, National Drug Research Institute Associate Professor Lynn Meuleners, Curtin Monash Accident Research Centre, National Drug Research Institute Dr Wenbin Liang, National Drug Research Institute Mr Gary Kirby, WA Drug and Alcohol Office, National Drug Research Institute

Office of Research and Development

Human Research Ethics Committee

TELEPHONE 9266 2784
FACSIMILE 9266 3793
EMAIL hrec@curtin.edu.au

Thank you for your application submitted to the Human Research Ethics Committee (HREC) for the project titled "*The effect of alcohol outlets and sales on alcohol-related injuries presenting at Emergency Departments in Perth, Australia from 2004 to 2009- PHASE 2".* Your application has been reviewed by the HREC and is **approved**.

- You have ethics clearance to undertake the research as stated in your proposal **(PHASE 2 ONLY)**.
- The approval number for your project is **HR 110/2011.** *Please quote this number in any future correspondence*.
- Approval of this project is for a period of twelve months **12/10/2011** to **12/10/2012**. To renew this approval a completed Form B (attached) must be submitted before the expiry date **12/10/2012**.
- If you are a Higher Degree by Research student, data collection must not begin before your Application for Candidacy is approved by your Faculty Graduate Studies Committee.
- The following standard statement **must be** included in the information sheet to participants:
  This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 110/2011). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au.

Applicants should note the following:
It is the policy of the HREC to conduct random audits on a percentage of approved projects. These audits may be conducted at any time after the project starts. In cases where the HREC considers that there may be a risk of adverse events, or where participants may be especially vulnerable, the HREC may request the chief investigator to provide an outcomes report, including information on follow-up of participants.

The attached **FORM B** should be completed and returned to the Secretary, HREC, C/- Office of Research & Development:
When the project has finished, or

- If at any time during the twelve months changes/amendments occur, or
- If a serious or unexpected adverse event occurs, or
- 14 days prior to the expiry date if renewal is required.
- An application for renewal may be made with a Form B three years running, after which a new application form (Form A), providing comprehensive details, must be submitted.

Regards,

A/Professor Stephan Millett
Chair Human Research Ethics Committee

Curtin University

Memorandum

To	Associate Professor Tanya Chikritzhs, National Drug Research Institute
From	Associate Professor Stephan Millett, Chair, Human Research Ethics Committee
Subject	Protocol Approval HR 110/2011
Date	9 January 2012
Copy	Mrs Michelle Hobday, National Drug Research Institute Associate Professor Lynn Meuleners, Curtin Monash Accident Research Centre, Dr Wenbin Liang, National Drug Research Institute Mr Gary Kirby, WA Drug and Alcohol Office

Office of Research and Development
Human Research Ethics Committee

TELEPHONE 9266 2784
FACSIMILE 9266 3793
EMAIL hrec@curtin .edu .au

Thank you for providing the additional information for the project titled *"The effect of alcohol outlets and soles on alcohol-related injuries presenting at Emergency Deportments in Perth, Australia from 2004 to 2009"*. The information you have provided has satisfactorily addressed the queries raised by the Committee. Your application is now approved for Phase 1, Phase 3 and Phase 4.

- You have ethics clearance to undertake the research as stated in your proposal.
- The approval number for your project is HR 110/2011. *Please quote this number in any future correspondence.*
- Approval of this project is for a period of twelve months 10-11-2011 to 10-11-2012. To renew this approval a completed Form B (attached) must be submitted before the expiry date 10-11-2012.
- If you are a Higher Degree by Research student, data collection must not begin before your Application for Candidacy is approved by your Faculty Graduate Studies Committee.
- The following standard statement must be included in the information sheet to participants:

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 110/2011). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect partici pants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin ·University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au.

Applicants should note the following:

It is the policy of the HREC to conduct random audits on a percentage of approved projects. These audits may be conducted at any time after the project starts. In cases where the HREC considers that there may be a risk of adverse events, or where participants may be especially vulnerable, the HREC may request the chief investigator to provide an outcomes report, including information on follow-up of participants.

The attached FORM B should be completed and returned to the Secretary, HREC, C/- Office of Research & Development:
When the project has finished, or

- If at any time during the twelve months changes/amendments occur, or
- If a serious or unexpected adverse event occurs, or
- 14 days prior to the expiry date if renewal is required.
- An application for renewal may be made with a Form B three years running, after which a new application form (Form A), providing comprehensive details, must be submitted.

Yours sincerely,

Associate Professor Stephan Millett
Chair Human Research Ethics Committee

10.2 Extraction form for the Data Linkage Branch

Government of **Western Australia**
Department of **Health**

Extraction

For Office Use Only	
EOI#	
DL#	

Please specify the data to be extracted, listing all data sets and specific detail around selection of a cohort or cases and controls. Any date limits should also be given. If you require assistance with completing this form, please email DataServices@health.wa.gov.au.

Please note: DOHWA HREC approval is required for any personal health information*.

*Personal health information is information or opinions that relate to the health of a person where the identity of a person is apparent or can reasonably be ascertained from the information. For a more detailed explanation see the *Practice Code For the Use of Personal Health Information*. All project personnel who will have access to personal health information provided by the DOHWA must enter into a Confidentiality Agreement. Please contact the Manager or Project Manager of the Data Linkage Branch or the DOHWA HREC Executive Officer if you are unsure of the criteria for "personal health information".

1. COHORT

Cohort Description
Please provide a description of your cohort and how your study population is defined. E.g. all people living in Bunbury who were diagnosed with lung cancer between 1995 and 2005, defined through the WA Cancer Registry
All people aged 15 and older and residing in the Perth metropolitan area who were admitted to metropolitan EDs between Jan 2002 and Dec 2010.
For quoting purposes please provide an estimate of how many people there will be in your cohort.
Unknown.
Disease and Procedure Codes
If your cohort is to be selected from specific disease or procedure groupings, please specify the version of ICD codes you require (i.e. ICD9, ICD10), and whether they should be applied only to the principal disease/procedure code or to any of the multiple codes within a record. For the time periods and versions of ICD codes used in WA please see http://www.datalinkage-wa.org.au/sites/default/files/HMDS_ICD_DRG.pdf **Please attach an Excel spreadsheet of all the specific ICD codes you require. Please note that the DLB cannot provide or check ICD codes.** E.g. ICD10, diagnosis codes for lung cancer. See attached spreadsheet.
N/A
Geographical areas
If your cohort is to be restricted to a specific residential or service area, please specify the relevant postcodes or CDs that define the area required. **Please attach an Excel spreadsheet of the postcodes or CDs you require.** *SEIFA and ARIA codes are available for Emergency, Death, Hospital and Midwives data. If you require SEIFA or ARIA codes, please select this in the variable lists for each dataset (Module 4).*

E.g. People residing in Bunbury. See attached spreadsheet of postcode and collection districts.
Metropolitan area only- metropolitan emergency departments. Postcodes of residence restricted to metropolitan area.
Service data extraction
Please specify the datasets you require and the time period. ***Attach variable lists (Module 3).**

Dataset E.g. Hospital Morbidity	**Time period** E.g. Jan 1995 – most recent
Emergency Data	January 2002 to December 2010

If you are requesting Hospital Morbidity data, please specify below whether you need all records to analyse co-morbidities or just the records associated with a particular condition. E.g. I wish to analyse comorbidities. Please extract all records for 5 years before and all after the index admission.
N/A
If you are requesting Cancer data, please indicate whether tumour records should be restricted by certain criteria. E.g. neoplasm type, diagnosis year, age at time of diagnosis, diagnosed while residing in WA. Note: "all cancers" will be interpreted as invasive, notifiable malignancies only. This excludes benign, in situ and uncertain behaviour neoplasms and all primary skin SCC and BCCs.
N/A
If you are requesting Midwives or Birth data, please specify below whether you need records for the birth of a person, records where they are the parent or both. E.g. I am only interested in records where the cases are mothers, not the records from their own birth.
N/A

2. CONTROLS

Control Group Description
Please provide a description of your controls. E.g. Random sample of people from the electoral roll, matched on year of birth and gender to the cohort 5:1.
N/A
Disease and Procedure Codes
If your controls are to be selected from specific disease or procedure groupings, please specify the version

of ICD codes you require (i.e. ICD9, ICD10), and whether they should be applied only to the principal disease/procedure code or to any of the multiple codes within a record. **Please attach an Excel spreadsheet of all the specific ICD codes you require**.
N/A
Geographical areas
If your controls are to be restricted to a specific residential or service area, please specify the relevant postcodes or CDs that define the area required. **Please attach an Excel spreadsheet of the postcodes or CDs you require.** *SEIFA and ARIA codes are available for Emergency, Death, Hospital and Midwives data. If you require SEIFA or ARIA codes, please select this in the variable lists for each dataset (Module 4).* E.g. People residing in Bunbury. See attached spreadsheet of postcode and collection districts.
N/A
Service data extraction
Please specify the datasets you require and the time period. ***Attach variable lists (Module 3).**

Dataset E.g. Hospital Morbidity	**Time period** E.g. Jan 1995 – most recent
N/A	

Variables
Do you require the same variables as your cohort? (Yes/No) **If not, please attach a separate variable list for the controls (Module 3).**
N/A
If you are requesting Hospital Morbidity data, please specify below whether you need all records to analyse co-morbidities or just the records associated with a particular condition. E.g. I wish to analyse comorbidities. Please extract all records for 5 years before and all after the index admission.
N/A
If you are requesting Cancer data, please indicate whether tumour records should be restricted by certain criteria. E.g. neoplasm type, diagnosis year, age at time of diagnosis, diagnosed while residing in WA. Note: “all cancers” will be interpreted as invasive, notifiable malignancies only. This excludes benign, in situ and uncertain behaviour neoplasms and all primary skin SCC and BCCs.
N/A
If you are requesting Midwives or Birth data, please specify below whether you need records for the birth of a person, records where they are the parent or both. E.g. I am only interested in records where the cases are mothers, not the records from their own birth.
N/A

10.3 Tables showing numbers for validation of surrogates

Table 10.1: All wholly alcohol-attributable cases presenting at Perth Metropolitan Area Emergency Departments from 1 July 2002 to 30 June 2010

	2002/3		2003/4		2004/5		2005/6		2006/7		2007/8		2008/9		2009/10		Total	
Hour	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Midnight-1am	153	8.24	162	9.74	159	8.20	212	9.18	233	9.67	194	8.14	198	7.85	269	9.11	1,580	8.76
1am-1:59am	157	8.45	124	7.45	172	8.87	170	7.36	199	8.26	176	7.39	176	6.98	212	7.18	1,386	7.68
2am-2:59am	97	5.22	95	5.71	125	6.45	141	6.10	150	6.22	173	7.26	145	5.75	172	5.83	1,098	6.09
3am-3:59am	78	4.20	58	3.49	95	4.90	86	3.72	96	3.98	122	5.12	115	4.56	111	3.76	761	4.22
4am-4:59am	46	2.48	40	2.40	60	3.09	64	2.77	75	3.11	55	2.31	63	2.50	61	2.07	464	2.57
5am-5:59am	36	1.94	27	1.62	42	2.17	40	1.73	30	1.24	54	2.27	50	1.98	45	1.52	324	1.80
6am-6:59am	28	1.51	30	1.80	26	1.34	26	1.13	32	1.33	27	1.13	33	1.31	46	1.56	248	1.37
7am-7:59am	24	1.29	21	1.26	24	1.24	21	0.91	28	1.16	31	1.30	36	1.43	42	1.42	227	1.26
8am-8:59am	20	1.08	21	1.26	24	1.24	29	1.26	34	1.41	29	1.22	33	1.31	39	1.32	229	1.27
9am-9:59am	41	2.21	20	1.20	31	1.60	35	1.52	38	1.58	45	1.89	35	1.39	46	1.56	291	1.61
10am-10:59am	28	1.51	41	2.46	37	1.91	41	1.77	43	1.78	52	2.18	61	2.42	67	2.27	370	2.05
11am-11:59am	42	2.26	39	2.34	39	2.01	64	2.77	44	1.83	59	2.48	48	1.90	74	2.51	409	2.27
Noon-12:59pm	50	2.69	51	3.06	63	3.25	65	2.81	63	2.61	70	2.94	69	2.73	76	2.57	507	2.81
1pm-1:59pm	51	2.75	46	2.76	63	3.25	66	2.86	59	2.45	72	3.02	88	3.49	94	3.18	539	2.99
2pm-2:59pm	57	3.07	50	3.00	68	3.51	74	3.20	77	3.20	79	3.32	82	3.25	117	3.96	604	3.35
3pm-3:59pm	92	4.95	59	3.55	75	3.87	90	3.90	97	4.02	84	3.53	89	3.53	97	3.29	683	3.79
4pm-4:59pm	91	4.90	89	5.35	78	4.02	89	3.85	83	3.44	91	3.82	106	4.20	141	4.78	768	4.26
5pm-5:59pm	64	3.45	67	4.03	74	3.82	110	4.76	99	4.11	100	4.20	138	5.47	138	4.67	790	4.38
6pm-6:59pm	98	5.28	78	4.69	94	4.85	111	4.81	119	4.94	107	4.49	123	4.88	152	5.15	882	4.89
7pm-7:59pm	99	5.33	96	5.77	101	5.21	123	5.32	118	4.90	121	5.08	122	4.84	167	5.66	947	5.25
8pm-8:59pm	116	6.25	97	5.83	92	4.74	153	6.62	161	6.68	141	5.92	140	5.55	178	6.03	1,078	5.98
9pm-9:59pm	107	5.76	104	6.25	109	5.62	126	5.45	153	6.35	131	5.50	182	7.21	169	5.72	1,081	5.99

10pm-10:59pm	140	7.54	110	6.61	138	7.12	160	6.93	168	6.97	181	7.60	184	7.29	197	6.67	1,278	7.09
11pm-11:59pm	142	7.65	139	8.35	150	7.74	214	9.26	211	8.76	188	7.89	207	8.20	242	8.20	1,493	8.28
Total	1,857	100	1,664	100	1,939	100	2,310	100	2,410	100	2,382	100	2,523	100	2,952	100	18,037	100

Table 10.2: All weekend wholly alcohol-attributable cases presenting at Perth Metropolitan Area Emergency Departments from 1 July 2002 to 30 June 2010

	2002/3		2003/4		2004/5		2005/6		2006/7		2007/8		2008/9		2009/10		Total	
Hour	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Midnight-1am	93	9.40	114	12.94	109	9.67	148	10.94	163	11.36	134	9.57	123	8.74	175	10.63	1,059	10.34
1am-1:59am	109	11.02	80	9.08	143	12.69	124	9.16	144	10.03	130	9.29	133	9.45	163	9.90	1,026	10.02
2am-2:59am	60	6.07	69	7.83	95	8.43	103	7.61	116	8.08	130	9.29	101	7.18	128	7.77	802	7.83
3am-3:59am	51	5.16	39	4.43	61	5.41	67	4.95	65	4.53	93	6.64	85	6.04	75	4.55	536	5.23
4am-4:59am	34	3.44	32	3.63	42	3.73	40	2.96	55	3.83	42	3.00	50	3.55	43	2.61	338	3.30
5am-5:59am	26	2.63	18	2.04	33	2.93	33	2.44	19	1.32	34	2.43	34	2.42	23	1.40	220	2.15
6am-6:59am	20	2.02	21	2.38	18	1.60	19	1.40	20	1.39	17	1.21	19	1.35	24	1.46	158	1.54
7am-7:59am	11	1.11	9	1.02	17	1.51	14	1.03	19	1.32	21	1.50	24	1.71	18	1.09	133	1.30
8am-8:59am	7	0.71	11	1.25	12	1.06	19	1.40	17	1.18	11	0.79	19	1.35	24	1.46	120	1.17
9am-9:59am	23	2.33	5	0.57	9	0.80	15	1.11	18	1.25	20	1.43	21	1.49	19	1.15	130	1.27
10am-10:59am	11	1.11	15	1.70	19	1.69	18	1.33	19	1.32	24	1.71	31	2.20	21	1.28	158	1.54
11am-11:59am	20	2.02	17	1.93	21	1.86	22	1.63	22	1.53	23	1.64	22	1.56	35	2.13	182	1.78
Noon-12:59pm	27	2.73	24	2.72	28	2.48	25	1.85	32	2.23	32	2.29	20	1.42	37	2.25	225	2.20
1pm-1:59pm	23	2.33	22	2.50	30	2.66	37	2.73	32	2.23	37	2.64	36	2.56	44	2.67	261	2.55
2pm-2:59pm	24	2.43	22	2.50	31	2.75	39	2.88	37	2.58	35	2.50	34	2.42	51	3.10	273	2.67
3pm-3:59pm	35	3.54	26	2.95	32	2.84	35	2.59	42	2.93	39	2.79	33	2.35	41	2.49	283	2.76
4pm-4:59pm	38	3.84	37	4.20	33	2.93	33	2.44	42	2.93	48	3.43	55	3.91	77	4.68	363	3.55
5pm-5:59pm	28	2.83	30	3.41	29	2.57	60	4.43	51	3.55	50	3.57	66	4.69	69	4.19	383	3.74
6pm-6:59pm	46	4.65	39	4.43	44	3.90	63	4.66	60	4.18	64	4.57	51	3.62	70	4.25	437	4.27
7pm-7:59pm	44	4.45	34	3.86	48	4.26	62	4.58	62	4.32	58	4.14	68	4.83	84	5.10	460	4.49
8pm-8:59pm	59	5.97	42	4.77	42	3.73	79	5.84	85	5.92	67	4.79	66	4.69	78	4.74	518	5.06
9pm-9:59pm	50	5.06	43	4.88	48	4.26	63	4.66	76	5.30	75	5.36	93	6.61	88	5.34	536	5.23

10pm-10:59pm	65	6.57	56	6.36	77	6.83	92	6.80	101	7.04	97	6.93	103	7.32	101	6.13	692	6.76
11pm-11:59pm	85	8.59	76	8.63	106	9.41	143	10.57	138	9.62	119	8.50	120	8.53	159	9.65	946	9.24
Total	989	100	881	100	1,127	100	1,353	100	1,435	100	1,400	100	1,407	100	1,647	100	10,239	100

Table 10.3: Young (15 to 44 year old) male weekend wholly alcohol-attributable cases presenting at Perth Metropolitan Area Emergency Departments from 1 July 2002 to 30 June 2010

	2002/3		2003/4		2004/5		2005/6		2006/7		2007/8		2008/9		2009/10		Total	
Hour	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Midnight-1am	38	10.41	44	12.54	40	8.73	56	10.07	57	9.25	55	9.15	56	9.29	76	10.53	357	8.35
1am-1:59am	34	9.32	33	9.40	72	15.72	56	10.07	66	10.71	49	8.15	53	8.79	70	9.70	373	8.72
2am-2:59am	22	6.03	35	9.97	42	9.17	50	8.99	52	8.44	66	10.98	49	8.13	55	7.62	324	7.58
3am-3:59am	19	5.21	14	3.99	28	6.11	40	7.19	30	4.87	39	6.49	31	5.14	32	4.43	205	4.81
4am-4:59am	12	3.29	16	4.56	17	3.71	25	4.50	25	4.06	20	3.33	33	5.47	20	2.77	151	3.53
5am-5:59am	11	3.01	9	2.56	15	3.28	14	2.52	11	1.79	18	3.00	17	2.82	8	1.11	96	2.25
6am-6:59am	9	2.47	12	3.42	7	1.53	12	2.16	9	1.46	9	1.50	7	1.16	9	1.25	66	1.55
7am-7:59am	4	1.10	4	1.14	7	1.53	7	1.26	14	2.27	11	1.83	13	2.16	8	1.11	61	1.43
8am-8:59am	4	1.10	2	0.57	6	1.31	11	1.98	6	0.97	7	1.16	9	1.49	6	0.83	46	1.07
9am-9:59am	11	3.01	1	0.28	2	0.44	4	0.72	8	1.30	9	1.50	11	1.82	7	0.97	47	1.10
10am-10:59am	2	0.55	3	0.85	6	1.31	4	0.72	9	1.46	8	1.33	9	1.49	9	1.25	42	0.99
11am-11:59am	7	1.92	7	1.99	8	1.75	7	1.26	9	1.46	9	1.50	10	1.66	14	1.94	59	1.38
Noon-12:59pm	8	2.19	5	1.42	10	2.18	7	1.26	10	1.62	10	1.66	6	1.00	17	2.35	58	1.37
1pm-1:59pm	9	2.47	10	2.85	11	2.40	5	0.90	14	2.27	12	2.00	17	2.82	24	3.32	81	1.90
2pm-2:59pm	6	1.64	8	2.28	13	2.84	17	3.06	12	1.95	11	1.83	9	1.49	20	2.77	79	1.84
3pm-3:59pm	9	2.47	11	3.13	11	2.40	8	1.44	21	3.41	18	3.00	7	1.16	21	2.91	88	2.06
4pm-4:59pm	16	4.38	14	3.99	10	2.18	9	1.62	11	1.79	19	3.16	20	3.32	36	4.99	104	2.43
5pm-5:59pm	11	3.01	6	1.71	14	3.06	27	4.86	18	2.92	19	3.16	27	4.48	29	4.02	126	2.95
6pm-6:59pm	13	3.56	16	4.56	14	3.06	32	5.76	27	4.38	31	5.16	26	4.31	33	4.57	164	3.83
7pm-7:59pm	20	5.48	11	3.13	18	3.93	25	4.50	23	3.73	23	3.83	32	5.31	41	5.68	158	3.69
8pm-8:59pm	19	5.21	14	3.99	21	4.59	30	5.40	37	6.01	29	4.83	27	4.48	27	3.74	181	4.23
9pm-9:59pm	16	4.38	16	4.56	17	3.71	25	4.50	28	4.55	40	6.66	38	6.30	30	4.16	184	4.31

10pm-10:59pm	28	7.67	24	6.84	30	6.55	39	7.01	51	8.28	43	7.15	39	6.47	46	6.37	260	6.09
11pm-11:59pm	37	10.14	36	10.26	39	8.52	46	8.27	68	11.04	46	7.65	57	9.45	84	11.63	341	7.97
Total	365	100	351	100	458	100	556	100	616	100	601	100	603	100	722	100	4,272	85.44

Table 10.4: All injury cases presenting at Perth Metropolitan Area Emergency Departments from 1 July 2002 to 30 June 2010

	2002/3		2003/4		2004/5		2005/6		2006/7		2007/8		2008/9		2009/10		Total	
Hour	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Midnight-1am	1,341	3.12	1,393	3.04	1,781	3.16	1,837	3.06	1,989	3.05	2,036	2.99	2,046	2.82	2,104	2.82	14,527	2.99
1am-1:59am	1,178	2.74	1,170	2.56	1,463	2.59	1,525	2.54	1,689	2.59	1,710	2.51	1,803	2.49	1,783	2.39	12,321	2.54
2am-2:59am	924	2.15	991	2.16	1,206	2.14	1,230	2.05	1,318	2.02	1,349	1.98	1,553	2.14	1,440	1.93	10,011	2.06
3am-3:59am	791	1.84	775	1.69	944	1.67	966	1.61	1,070	1.64	1,080	1.59	1,232	1.70	1,142	1.53	8,000	1.65
4am-4:59am	628	1.46	611	1.33	753	1.33	824	1.37	881	1.35	949	1.39	875	1.21	861	1.16	6,382	1.31
5am-5:59am	509	1.18	555	1.21	670	1.19	657	1.09	781	1.20	811	1.19	817	1.13	823	1.10	5,623	1.16
6am-6:59am	695	1.61	731	1.60	857	1.52	1,008	1.68	1,031	1.58	1,036	1.52	1,076	1.48	1,102	1.48	7,536	1.55
7am-7:59am	1,141	2.65	1,225	2.68	1,620	2.87	1,762	2.94	1,672	2.57	1,798	2.64	1,876	2.59	2,152	2.89	13,246	2.73
8am-8:59am	1,681	3.91	1,792	3.91	2,345	4.15	2,467	4.11	2,671	4.10	2,893	4.25	2,910	4.01	3,119	4.19	19,878	4.09
9am-9:59am	2,200	5.11	2,408	5.26	3,048	5.40	3,326	5.54	3,766	5.78	3,916	5.75	4,142	5.71	4,315	5.79	27,121	5.59
10am-10:59am	2,256	5.24	2,394	5.23	3,095	5.48	3,472	5.79	3,941	6.05	4,052	5.95	4,249	5.86	4,510	6.05	27,969	5.76
11am-11:59am	2,358	5.48	2,537	5.54	3,349	5.93	3,420	5.70	3,906	6.00	4,232	6.21	4,392	6.06	4,626	6.21	28,820	5.94
Noon-12:59pm	2,263	5.26	2,507	5.47	3,116	5.52	3,389	5.65	3,696	5.67	4,021	5.90	4,282	5.90	4,377	5.88	27,651	5.69
1pm-1:59pm	2,354	5.47	2,431	5.31	3,098	5.49	3,403	5.67	3,584	5.50	3,836	5.63	4,155	5.73	4,461	5.99	27,322	5.63
2pm-2:59pm	2,291	5.32	2,453	5.36	3,180	5.63	3,359	5.60	3,642	5.59	3,785	5.56	4,095	5.65	4,227	5.67	27,032	5.57
3pm-3:59pm	2,156	5.01	2,514	5.49	3,059	5.42	3,369	5.61	3,521	5.41	3,680	5.40	4,076	5.62	4,079	5.48	26,454	5.45
4pm-4:59pm	2,370	5.51	2,618	5.72	3,215	5.70	3,413	5.69	3,611	5.54	3,739	5.49	4,113	5.67	4,150	5.57	27,229	5.61
5pm-5:59pm	2,521	5.86	2,619	5.72	3,289	5.83	3,595	5.99	3,822	5.87	3,943	5.79	4,190	5.78	4,388	5.89	28,367	5.84
6pm-6:59pm	2,706	6.29	2,745	5.99	3,229	5.72	3,478	5.80	3,711	5.70	3,695	5.42	4,033	5.56	4,273	5.74	27,870	5.74
7pm-7:59pm	2,606	6.05	2,828	6.18	3,300	5.85	3,423	5.70	3,719	5.71	3,773	5.54	4,025	5.55	4,174	5.60	27,848	5.74
8pm-8:59pm	2,366	5.50	2,632	5.75	2,860	5.07	3,036	5.06	3,325	5.10	3,565	5.23	3,737	5.15	3,851	5.17	25,372	5.23
9pm-9:59pm	2,235	5.19	2,211	4.83	2,526	4.48	2,670	4.45	2,945	4.52	3,029	4.45	3,342	4.61	3,268	4.39	22,226	4.58

10pm-10:59pm	1,831	4.25	1,982	4.33	2,425	4.30	2,353	3.92	2,589	3.97	2,779	4.08	3,030	4.18	2,930	3.93	19,919	4.10
11pm-11:59pm	1,643	3.82	1,669	3.64	2,013	3.57	2,025	3.37	2,253	3.46	2,411	3.54	2,473	3.41	2,340	3.14	16,827	3.47
Total	43,044	100	45,791	100	56,441	100	60,007	100	65,133	100	68,118	100	72,522	100	74,495	100	485,551	100

Table 10.5: Young (15 to 44 year old) male weekend injury cases presenting at Perth Metropolitan Area Emergency Departments from 1 July 2002 to 30 June 2010

	2002/3		2003/4		2004/5		2005/6		2006/7		2007/8		2008/9		2009/10		Total	
Hour	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Midnight-1am	421	4.18	410	3.85	571	4.35	635	4.47	659	4.32	732	4.61	675	4.08	664	4.12	4,107	4.29
1am-1:59am	449	4.45	408	3.83	559	4.26	610	4.29	599	3.92	680	4.28	658	3.98	682	4.24	3,967	4.14
2am-2:59am	368	3.65	395	3.71	508	3.87	480	3.38	510	3.34	576	3.63	592	3.58	522	3.24	3,432	3.58
3am-3:59am	304	3.02	292	2.74	336	2.56	405	2.85	425	2.78	424	2.67	473	2.86	392	2.43	2,661	2.78
4am-4:59am	224	2.22	233	2.19	256	1.95	299	2.10	330	2.16	348	2.19	326	1.97	286	1.78	2,018	2.11
5am-5:59am	144	1.43	156	1.47	204	1.55	206	1.45	257	1.68	255	1.60	257	1.55	208	1.29	1,480	1.55
6am-6:59am	159	1.58	183	1.72	185	1.41	243	1.71	240	1.57	248	1.56	215	1.30	225	1.40	1,474	1.54
7am-7:59am	220	2.18	256	2.41	286	2.18	322	2.27	304	1.99	335	2.11	361	2.18	354	2.20	2,086	2.18
8am-8:59am	319	3.16	312	2.93	415	3.16	466	3.28	496	3.25	518	3.26	501	3.03	520	3.23	3,030	3.16
9am-9:59am	364	3.61	416	3.91	505	3.85	581	4.09	647	4.24	645	4.06	733	4.43	714	4.43	3,895	4.07
10am-10:59am	429	4.26	468	4.40	548	4.18	687	4.84	767	5.02	727	4.58	801	4.84	831	5.16	4,432	4.63
11am-11:59am	479	4.75	496	4.66	654	4.98	666	4.69	775	5.07	847	5.33	804	4.86	905	5.62	4,727	4.94
Noon-12:59pm	505	5.01	532	5.00	727	5.54	752	5.29	838	5.49	826	5.20	865	5.23	882	5.48	5,050	5.27
1pm-1:59pm	577	5.72	548	5.15	664	5.06	765	5.38	822	5.38	835	5.26	915	5.53	970	6.02	5,132	5.36
2pm-2:59pm	582	5.77	629	5.91	784	5.98	838	5.90	895	5.86	862	5.43	973	5.88	968	6.01	5,569	5.82
3pm-3:59pm	515	5.11	631	5.93	781	5.95	853	6.00	892	5.84	928	5.84	1,014	6.13	937	5.82	5,620	5.87
4pm-4:59pm	587	5.82	650	6.11	840	6.40	880	6.19	910	5.96	974	6.13	970	5.86	961	5.97	5,817	6.07
5pm-5:59pm	610	6.05	635	5.97	822	6.26	887	6.24	877	5.74	951	5.99	978	5.91	945	5.87	5,766	6.02
6pm-6:59pm	580	5.75	581	5.46	687	5.24	746	5.25	815	5.34	811	5.10	903	5.46	872	5.42	5,128	5.36
7pm-7:59pm	526	5.22	580	5.45	648	4.94	744	5.24	726	4.75	759	4.78	805	4.87	800	4.97	4,793	5.01
8pm-8:59pm	433	4.30	552	5.19	546	4.16	566	3.98	658	4.31	699	4.40	721	4.36	710	4.41	4,179	4.36
9pm-9:59pm	475	4.71	439	4.13	517	3.94	541	3.81	608	3.98	635	4.00	677	4.09	588	3.65	3,896	4.07

10pm-10:59pm	392	3.89	411	3.86	536	4.09	512	3.60	613	4.01	628	3.95	662	4.00	585	3.63	3,758	3.92
11pm-11:59pm	419	4.16	429	4.03	542	4.13	524	3.69	609	3.99	646	4.07	662	4.00	579	3.60	3,835	4.00
Total	10,081	100	10,642	100	13,121	100	14,208	100	15,272	100	15,889	100	16,541	100	16,100	100	95,854	100

10.4 Pilot questionnaire

Alcohol Purchasing Habits Questionnaire

Section 1: Demographic Information

1. Do you purchase alcohol for the personal use of you or your family? (please tick the answer which applies)

☐ Yes

☐ No

2. Who usually buys alcohol in your household? (please tick the answer which applies)

☐ I do
☐ My partner does
☐ Another member of the household

3. How old are you?

____

4. What is your gender? (please tick the answer which applies)

☐ Male
☐ Female

5. What state or territory do you live in? (please tick the answer which applies)

☐ ACT
☐ New South Wales
☐ Northern Territory
☐ Queensland
☐ South Australia
☐ Tasmania
☐ Victoria
☐ Western Australia

6. What postcode and suburb do you live in?

____

7. Are you and/or another adult in your household working? (please tick the answer which applies)

☐ Yes
☐ No

8. If you work, what postcode and suburb do you work in?

____

____

9. What is your household income per year before tax?

☐ < $50 000
☐ $50 000 to $74 999
☐ $75 000 to $99 999
☐ $100 000 to $ 149 999
☐ $150 000 to $199 999
☐ >$200 000

Section 2: Drinking Patterns

10. On average, what is the number of drinks that you typically drink at one sitting?

____

11. How often do you drink this amount? (please tick the answer that applies)

☐ Daily
☐ almost every day
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ once a month
☐ less than once a month

12. Right now, what is the most number of drinks that you drink at one sitting?

____

____

13. How often do you drink this amount? (please tick the answer that applies)

☐ Daily
☐ almost every day
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ once a month
☐ less than once a month,

Section 3: Purchasing Patterns

14. In which suburb do you usually buy alcohol from a liquor store (you buy it at the store and drink it somewhere else)?

____

15. In which suburb do you usually buy alcohol to drink without a meal (you buy and consume it at the same location eg a hotel or nightclub)?

____

16. In which suburb do you usually buy and consume alcohol with a meal such as at a restaurant or café?

____

17. How far are you prepared to travel to a liquor store to buy alcoholic drinks? (please tick the answer which applies)

☐ <5km (less than 6 minutes driving in light traffic)
☐ 5km to 10km (6 to 13 minutes)
☐ 10km to 20km (13 to 26 minutes)
☐ 20km to 50km (15 to 40 minutes)
☐ >50km (more an hour)
☐ I don't buy alcohol from a liquor store

18. How far are you prepared to travel to a hotel or nightclub to buy alcoholic drinks? (please tick the answer which applies)

☐ <5km (less than 6 minutes driving in light traffic)
☐ 5km to 10km (6 to 13 minutes)
☐ 10km to 20km (13 to 26 minutes)
☐ 20km to 50km (15 to 40 minutes)
☐ >50km (more an hour)
☐ I don't buy alcohol from a hotel or nightclub

19. How far are you prepared to travel to a restaurant or café to buy a meal and alcoholic drinks? (please tick the answer which applies)

☐ <5km (less than 6 minutes driving in light traffic)
☐ 5km to 10km (6 to 13 minutes)
☐ 10km to 20km (13 to 26 minutes)
☐ 20km to 50km (15 to 40 minutes)
☐ >50km (more an hour)
☐ I don't buy alcohol from a restaurant or café

20. *If you don’t buy alcohol from a liquor store, go to question 22*
For a 10% price discount at a liquor store (eg buy 6 bottles of wine, get a 10% discount on the normal price per bottle) , how much further would you be prepared to travel:(please tick the answer which applies)

☐ No further
☐ <5km further
☐ 5km to 10km
☐ 10km to 20km
☐ 20km to 50km
☐ >50km

21. For a 50% price discount at a liquor store (eg buy one, get one free) , how much further would you be prepared to travel (please tick the answer which applies):

☐ No further
☐ <5km further
☐ 5km to 10km
☐ 10km to 20km
☐ 20km to 50km
☐ >50km

22. *If you don’t buy alcohol from a hotel or nightclub, go to question 24.*
For a 10% price discount at a hotel or nightclub , how much further would you be prepared to travel(please tick the answer which applies):

☐ No further
☐ <5km further
☐ 5km to 10km
☐ 10km to 20km
☐ 20km to 50km
☐ >50km

23. For a 50% price discount at a hotel or nightclub , how much further would you be prepared to travel (please tick the answer which applies):

☐ No further
☐ <5km further
☐ 5km to 10km
☐ 10km to 20km
☐ 20km to 50km
☐ >50km

24. *If you don't buy alcohol from a restaurant or café, go to question 26.*
For a 10% price discount at a restaurant or café, how much further would you be prepared to travel (please tick the answer which applies):

☐ No further
☐ <5km further
☐ 5km to 10km
☐ 10km to 20km
☐ 20km to 50km
☐ >50km

25. For a 50% price discount at a restaurant or café, how much further would you be prepared to travel:(please tick the answer which applies)

☐ No further
☐ <5km further
☐ 5km to 10km
☐ 10km to 20km
☐ 20km to 50km
☐ >50km

26. What mode of transport do you use when purchasing alcohol? (please tick the answer which applies):

☐ Walk
☐ Drive car
☐ Cycle
☐ Motorbike
☐ Use public transport

27. What factors influence where you buy alcoholic drinks? (Tick all that apply):

☐ Proximity to home
☐ Proximity to work
☐ Proximity to shopping centre
☐ Price
☐ Choice of drinks
☐ Other (please specify)

28. Do you think the distance you are prepared to travel to buy alcohol has changed in the last five years?(please tick the answer which applies):

- ☐ Would travel further to buy alcohol five years ago
- ☐ Would travel less to buy alcohol five years ago
- ☐ Same distance now as five years ago
- ☐ I was under 18 years old or not drinking alcohol five years ago *(go to question 30)*

29. Why do you travel a different distance to five years ago?(please tick the answer which applies):

- ☐ Cost of petrol
- ☐ Cost of alcohol
- ☐ New liquor store has opened in a more convenient location
- ☐ Have moved house
- ☐ Other (please specify)

____

____

____

30. If the price of your usual beer increased by 10%, how would this effect your purchasing behaviour (please any answers that apply to you):

- ☐ I do not buy beer
- ☐ It would not change how what I bought
- ☐ I would buy less of my usual beer
- ☐ I would buy my usual beer less often
- ☐ I would buy a cheaper brand of beer
- ☐ I would buy a cheaper type of alcoholic drink (not beer)

31. *If you would buy less of your usual beer, please answer this question. Otherwise, continue with question 32:*
If you were planning to buy 24 beers, but the price of your usual beer increased by 10%, how many would you buy?

____

____

32. If the price of your favourite bottle of wine increased by 10%, how would this effect your purchasing behaviour (please any answers that apply to you):

- ☐ I do not buy wine
- ☐ It would not change how what I bought
- ☐ I would buy fewer bottles of my favourite wine
- ☐ I would buy my favourite wine less often
- ☐ I would buy a cheaper brand of wine
- ☐ I would buy a cheaper type of alcoholic drink (not wine)

33. *If you would buy less of your favourite bottle of wine, please answer this question. Otherwise, continue with question 34:*
If you were planning to buy 6 bottles of wine, but the price of your favourite bottle of wine increased by 10%, how many would you buy?

____
____

34. If the price of your usual bottle of spirits increased by 10%, how would this effect your purchasing behaviour (please any answers that apply to you):

- ☐ I do not buy spirits
- ☐ It would not change how what I bought
- ☐ I would buy less of my usual brand of spirits
- ☐ I would buy my usual brand of spirits less often
- ☐ I would buy a cheaper brand of spirits
- ☐ I would buy a cheaper type of alcoholic drink (not spirits)

35. *If you would buy less of your usual spirits, please answer this question. Otherwise, you have completed the questionnaire.*
If you were planning to buy 6 bottles of your usual brand of spirits, but the price increased by 10%, how many would you buy?

____
____

Thank you for completing the questionnaire.

10.5 Pilot study reliability test results

Table 10.6: Pilot study reliability results for questionnaire (kappa tests) in Perth, 2012

Question no.	Question	Kappa score	Weighted (w)/not(n)
7	Are you and/or another adult in your household working?	0.84	n
9	What is your household income per year before tax?	0.92	w
10	On average, what is the number of drinks that you typically drink at one sitting?	0.74	w
11	How often do you drink this amount?	0.91	w
12	Right now, what is the most number of drinks that you drink at one sitting?	0.87	w
13	How often do you drink this amount?	0.82	w
17	How far are you prepared to travel to a liquor store to buy alcoholic drinks?	0.53	w
18	How far are you prepared to travel to a hotel or nightclub to buy alcoholic drinks?	0.56	w
19	How far are you prepared to travel to a restaurant or café to buy a meal and alcoholic drinks?	0.70	w
20	For a 10% price discount at a liquor store (eg buy 6 bottles of wine, get a 10% discount on the normal price per bottle) , how much further would you be prepared to travel?	0.37	w
21	For a 50% price discount at a liquor store (eg buy one, get one free) , how much further would you be prepared to travel?	0.80	w
22	For a 10% price discount at a hotel or nightclub, how much further would you be prepared to travel?	0.23	w
23	For a 50% price discount at a hotel or nightclub, how much further would you be prepared to travel?	0.83	w
24	For a 10% price discount at a restaurant or café, how much further would you be prepared to travel?	0.41	w
25	For a 50% price discount at a restaurant or café, how much further would you be prepared to travel?	0.44	w
26	What mode of transport do you use when purchasing alcohol?	0.52	n
27	What factors influence where you buy alcoholic drinks?	0.45	n
28	Do you think the distance you are prepared to travel to buy alcohol has changed in the last five years?	0.74	n
29	Why do you travel a different distance to five years ago?	0.55	n
30	If the price of your usual beer increased by 10%, how would this affect your purchasing behaviour?	0.71	n
32	If the price of your favourite bottle of wine increased by 10%, how would this affect your purchasing behaviour?	0.61	n

34	If the price of your usual bottle of spirits increased by 10%, how would this affect your purchasing behaviour?	0.82	n

10.6 Sample size calculation for online survey

Equation 10.1: Sample size calculation for online survey of alcohol purchasing behaviour, in the Australian capital cities in 2012

$$SE^2 = \frac{p(1-p)}{n}$$

then $n = \frac{p(1-p)}{SE^2}$

n=[p(1-p)]/[0.025*0.025]=p(1-p)/0.000625

given: p>=0 & p<=1, then when p=0.5, p(1-p) is highest: 0.25

p=0.5+x , -0.5<=x<=0.5 then p(1-p)=(0.5+x)*(0.5-x) =0.25-x*x,

when x=0, p(1-p) reaches its highest value: 0.25

0.25/0.000625=400

To analyse males and females separately: 400*2=800

10.7 Sample quotas for online survey by Pureprofile

Table 10.7: Quotas used by Pureprofile in the online survey to get representative sample, in the Australian capital cities in 2012

SEIFA category	1			2			3			4			Total		
Age (years)	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
18-24	13	12	25	13	12	25	13	12	25	13	12	25	52	48	100
25-34	18	18	36	18	18	36	18	18	36	18	18	36	72	72	144
35-44	19	20	39	19	20	39	19	20	39	19	20	39	76	80	156
45-54	18	18	36	18	18	36	18	18	36	18	18	36	72	72	144
55-64	15	14	29	15	14	29	15	14	29	15	14	29	60	56	116
65+	17	18	35	17	18	35	17	18	35	17	18	35	68	72	140
Total	100	100	200	100	100	200	100	100	200	100	100	200	400	400	800

Table 10.8: Quotas used by Pureprofile in the online survey to get further participants, in the Australian capital cities in 2012

Gender	Male	Female	Total
SEIFA level			
1	100	100	200
2	100	100	200
3	95	100	195
4	100	100	200
Total	395	400	795

10.8 Final questionnaire

ALCOHOL PURCHASING HABITS QUESTIONNAIRE

Hi. Thank you for agreeing to participate in this survey. We are interested in the buying and consumption habits of Australian drinkers, especially how price and distance to alcohol outlets influence the choices that drinkers make. Please complete this questionnaire only if you currently purchase alcohol for yourself or your household.

This survey starts by asking questions about you and your drinking preferences. It then asks how distance to outlets and price discounting influence your purchasing decisions. For some questions you will be asked to select the single answer which best applies but at other times you will be asked to select as many options as apply and, occasionally, to rank them in order of importance.

Section 1: Demographic Information

1 Do you purchase alcohol for your own personal use or for the use of your family or housemates? *Mark one response only*.

☐ Yes

☐ No. If you answered ‘No’, do not continue with any further questions. Thank you for your time.

2 Have you lived in Australia for at least 12 months? *Mark one response only*.

☐ Yes

☐ No. If you answered ‘No’, do not continue with any further questions. Thank you for your time.

3 Who usually buys alcohol in your household? *Mark one response only*.

☐ I do
☐ My partner does
☐ Both my partner and I do
☐ My housemate(s) do(es)
☐ Both my housemate(s) and I do
☐ Other

4 How old are you? *Please type your answer in the space provided.*

____

5 What is your gender? *Mark one response only*.

☐ Male
☐ Female

6 What is your current marital status? *Mark one response only*.

☐ Never married
☐ Widowed
☐ Divorced
☐ Separated but not divorced
☐ Married (including de facto or living with life partner)

7 Are you of Aboriginal and/or Torres Strait Islander origin? *Mark one response only*.

☐ No
☐ Yes, Aboriginal
☐ Yes, Torres Strait Islander
☐ Yes, both Aboriginal and Torres Strait Islander

8 In which country were you born? *Mark one response only*.

☐ Australia
☐ China
☐ Germany
☐ Greece
☐ Hong Kong
☐ India
☐ Ireland (Republic of)
☐ Italy
☐ Lebanon
☐ Malaysia
☐ Malta
☐ Netherlands
☐ New Zealand
☐ Philippines
☐ Poland
☐ South Africa
☐ Turkey
☐ United Kingdom (England, Scotland, Wales, Northern Ireland)
☐ USA
☐ Vietnam
☐ Yugoslavia (The former)
☐ Other (*Please type your answer in the space provided)*

____

9 Is English the main language spoken in your home? *Mark one response only*.

☐ Yes (*Go to Question 11*)
☐ No (*Go to Question 10*)

10 If you answered 'No' to Question 9, what language is mainly spoken? *Please type your answer in the space provided.*

____

11 In the last 12 months, in what state or territory did you live most of the time, i.e. for more than 6 months? *Mark one response only*.

☐ ACT
☐ New South Wales
☐ Northern Territory
☐ Queensland
☐ South Australia
☐ Tasmania
☐ Victoria
☐ Western Australia

12 In the last 12 months, in what suburb and/or postcode did you live most of the time, i.e. more than 6 months? (e.g. Wembley, 6014). *Please type your answer in the space provided.*

____

13 Are you in paid employment outside the home, i.e. in addition to home duties? *Mark one response only*.

☐ Yes
☐ No (*Go to Question 15*)

14 If you answered 'Yes' to Questions 13, in which suburb and/or postcode do you usually work (e.g. Brisbane city, 4072)? If your work involves travelling, name the suburb in which your company is based. *Please type your answer in the space provided.*

____

____

15 How many adults and dependents usually live in your household including all those with whom you live and share expenses, i.e. your partner, family members, foster children, housemates? *Please type your answer in the spaces provided.*

a. Adults: __________________________

b. Dependents (i.e. any person who is financially dependent such as children or full-time students):___________

16 Including yourself, how many adults living in your house contribute towards household bills and expenses? For example, if you are the only adult contributing to household expenses select '1'. If both you and your partner contribute, select '2'. If you share expenses with two other housemates then select '3'.

☐ 1
☐ 2
☐ 3
☐ 4 or more

17 Which of the following options best represents your personal annual income, before tax, from all sources?

☐ < $50 000
☐ $50 000 to $74 999
☐ $75 000 to $99 999
☐ $100 000 to $ 149 999
☐ $150 000 to $199 999
☐ >$200 000

18 Which of the following options best represents the combined household annual income (e.g. including your partner, other family member(s), housemate), before tax, from all sources?

☐ < $50 000
☐ $50 000 to $74 999
☐ $75 000 to $99 999
☐ $100 000 to $ 149 999
☐ $150 000 to $199 999
☐ >$200 000

Section 2: Drinking Patterns

The questions in this section ask about your own use of alcohol and that of your partner in the past **12 months.** We have included pictures of common Australian standard drink sizes to help you to estimate your alcohol consumption. [Pictures on screen to demonstrate common standard drinks]

19 There are two parts to this question: please answer both a) and b).

a. In the past **12 months,** how often did you have an alcoholic drink of any kind? *Mark one response only.*

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

b. On the days that you have an alcoholic drink, how many standard drinks do you usually have? (1 standard drink contains 10 grams of alcohol, see picture prompts) *Mark one response only.*

☐ 15 or more drinks
☐ 13 -14 drinks
☐ 11-12 drinks
☐ 7-10 drinks
☐ 5-6 drinks
☐ 3-4 drinks
☐ 1-2 drinks

20 There are two parts to this question: please answer both a) and b).

a. What is the largest number of standard drinks that you have consumed during one sitting in the past 12 months? *Please type your answer in the space provided.*

____

____

b. How often do you drink this amount? *Mark one response only*.

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

21 This question asks about your preferred alcoholic beverage(s). Please answer parts a) and b) in the table below.

a. What type of alcoholic beverage do you **usually** drink (i.e. most often)? Mark one response only in the column labelled **Usual Drink**.

b. What **other** types of alcoholic drinks do you consume? Mark all boxes that apply under the column labelled **Other drinks.** Leave all the boxes blank if you do not drink any other type of alcoholic beverage.

Type of alcohol	**Usual Drink** (*choose one only*)	**Other drinks** (*tick all that apply*)
Regular strength beer	☐	☐
Mid strength beer	☐	☐
Low strength beer	☐	☐
Cask wine	☐	☐
Bottled wine (labeled)	☐	☐
Cider	☐	☐
Bottled wine unlabeled, i.e. ‘cleanskins’	☐	☐
Fortified wine, port, vermouth, sherry	☐	☐
Pre-mixed spirits in a bottle (e.g. Lemon Ruski, Stoli, Sub Zero)	☐	☐
Bottled spirits (e.g. scotch, vodka), with or without a mixer (e.g. water, cola)	☐	☐
Pre-mixed spirits in a can (e.g. UDL, Jim Beam and Cola)	☐	☐
Other (*specify in the space provided*)		

22 Does your partner or any of the adults with whom you share your house usually share in the consumption of the alcohol which you purchase? *If you do not currently have a partner or a housemate mark ‘not applicable’. Mark one response only.*

☐ Yes
☐ No (*Go to Question 24*)
☐ Not applicable (*Go to Question 24*)

23 If you answered ‘Yes’ to Question 22, approximately what proportion of the purchases which you make do you also consume? *Specify in the space provided.*
________________%

Section 3: Price Increases and Purchasing Patterns

The questions in this section ask you to think about how changes in the price of a particular type of alcoholic beverage would influence your decisions to purchase that product. For example, if the price of your usual beer increased from $40 to $44 per carton (10%) or the price of your usual wine increased from $10 to $20 (100%), how do you think that would influence your next purchasing decision? Assume that the price of the product you usually buy has increased at all stores, and it is not possible to shop around for a better deal on that product.

24 This question relates to **beer** purchases. *If you do not buy beer then go to Question 25.* If the price of the beer you usually purchase *increased* by the percentages indicated in the table below (i.e. 10%, 25%, 50%, 100%), how would this influence your purchasing decision? *For each row, mark one response only.*

	Beer purchasing decision				
Price increase	I would not change what I bought	I would buy less of my usual beer	I would buy my usual beer less often	I would buy a cheaper brand of beer	I would buy a different type of alcoholic beverage (i.e. not beer) that is cheaper
10%	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐
100%	☐	☐	☐	☐	☐

25 This question relates to **wine** purchases. *If you do not buy wine then go to Question 26.* If the price of your usual bottle or cask of wine increased by the percentages indicated in the table below (i.e. 10%, 25%, 50%, 100%), how would this influence your purchasing decision? *For each column, mark one response only.*

	Wine purchasing decision				
Price increase	I would not change what I bought	I would buy less of my usual wine	I would buy my usual wine less often	I would buy a cheaper brand of wine	I would buy a different type of alcoholic beverage (i.e. not wine) that is cheaper
10%	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐
100%	☐	☐	☐	☐	☐

26 This question relates to purchases of bottled **spirits**, that is, *straight* spirits (e.g. scotch, vodka, rum) but *not* pre-mixed spirits (e.g. UDL, alcopops). *If you do not buy straight spirits then go to Question 27.*

If the price of your usual bottle of spirits increased by the percentages indicated in the table below (i.e. 10%, 25%, 50%, 100%), how would this influence your purchasing decision? *For each column, mark one response only.*

	Spirits purchasing decision				
Price increase	I would not change what I bought	I would buy less of my usual spirits	I would buy my usual spirits less often	I would buy a cheaper brand of spirits	I would buy a different type of alcoholic beverage (i.e. not spirits) that is cheaper
10%	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐
100%	☐	☐	☐	☐	☐

27 This question relates to purchases of **pre-mixed spirits** (e.g. UDL, alcopops, ready-to-drink, Ruski). *If you do not buy pre-mixed spirits then go to Question 28.*
If the price of your usual pre-mixed spirits increased by the percentages indicated in the table below (i.e. 10%, 25%, 50%, 100%), how would this influence your purchasing decision? *For each column, mark one response only.*

	Pre-mixed purchasing decision				
Price increase	I would not change what I bought	I would buy less of my usual pre-mixed spirits	I would buy my usual pre-mixed spirits less often	I would buy a cheaper brand of pre-mixed spirits	I would buy a different type of alcoholic beverage (i.e. not pre-mixed spirits) that is cheaper
10%	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐
100%	☐	☐	☐	☐	☐

28 This question relates to purchases of **<u>cider</u>** (e.g. Strongbow, Mercury Cider, Three Oaks Cider, Bulmers). *If you do not buy cider then go to Question 29.*

If the price of your favourite type of cider increased by the percentages indicated in the table below (i.e. 10%, 25%, 50%, 100%), how would this influence your purchasing decision? *For each column, mark one response only.*

	Cider purchasing decision				
Price increase	I would not change what I bought	I would buy less of my usual cider	I would buy my usual cider less often	I would buy a cheaper brand of cider	I would buy a different type of alcoholic beverage (i.e. not cider) that is cheaper
10%	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐
100%	☐	☐	☐	☐	☐

Section 4: Distance and Purchasing Patterns

This section asks you to think about how the distance you are required to travel in order to obtain your usual beverage influences your purchasing decisions. You will be asked a similar set of questions for each type of liquor outlet.

29 What mode of transport do you usually use when purchasing alcohol? *Mark all boxes that apply.*

☐ Walk
☐ Drive a car
☐ Bicycle
☐ Motorbike
☐ Use public transport
☐ Other (*please specify in the space provided*)

____

____

30 The following is a list of factors that may influence where you buy alcoholic drinks. Rank them in order of importance with ‘1’ being the most important and ‘9’ the least important (*it is important that you do not use the same number twice).* For example, if closeness to home is the most important reason why you choose that outlet, then mark ‘closeness to home’ with a ‘1’. If price is the second most important reason, mark ‘price of drinks’ as ‘2’, and so on. *Make sure you fill in all the boxes.*

☐ Opening hours of the licensed premises
☐ How busy or tired I am at the time
☐ Closeness to home
☐ Price of drinks
☐ Closeness to work
☐ On the route between work and home
☐ Closeness to the shopping centre where I usually shop
☐ Price of petrol
☐ Choice or variety of drinks available

31 Is there another important factor that influences where you buy alcoholic drinks which is not included in Question 30 above? If yes, give a brief description in the space provided.

32 Which of the following reasons would cause you to travel further to buy alcohol? *Mark all boxes that apply.*

- ☐ Cheaper prices
- ☐ More choice or variety of drinks available
- ☐ Longer or more convenient opening hours
- ☐ Located in an entertainment district with more choice of venues
- ☐ Other (*please specify in the space provided*)

33 This question asks about whether the distance you travel to obtain alcohol has changed in the past **5 years**. It has two parts: a) and b)

a. Do you think the distance you travel to buy alcohol has changed in the last five years? *Mark one response only.*

- ☐ Yes, I now travel *further* to buy alcohol than I did five years ago
- ☐ Yes, I now travel a *shorter* distance to buy alcohol than I did five years ago
- ☐ No, I travel about the same distance now as I did five years ago *(go to question 34)*
- ☐ No, I did not drink alcohol five years ago *(go to question 34)*

b. If you answered 'Yes' to part a) above, why do you now travel a different distance compared to five years ago? *Mark all that apply.*

- ☐ Increasing price of petrol
- ☐ To get a cheaper price on alcohol
- ☐ A new licensed premises has opened in a more convenient location
- ☐ A new licensed premises has opened which sells alcohol at a cheaper price
- ☐ I have moved house
- ☐ I drink less than I used to
- ☐ I drink more than I used to
- ☐ My mode of transport has changed (e.g. I bought a car)
- ☐ Other (*please specify in the space provided*)

34 This question asks about where you buy alcohol from. Please answer both part a) and b).

a. Where do you usually (i.e. most often) buy alcohol? *Mark one response only.*

- ☐ Bottle shop (excluding supermarket liquor stores)
- ☐ Liquor section of a supermarket or a liquor store attached to a supermarket
- ☐ Pub (hotel or tavern)
- ☐ Nightclub
- ☐ Restaurant or café
- ☐ Internet
- ☐ Mail order
- ☐ Duty free shopping
- ☐ Other (*please specify in the space provided*)

b. Where else do you buy alcohol? *Mark all that apply.*

☐ Bottle shop (excluding supermarket liquor stores)
☐ Liquor section of a supermarket or a liquor store attached to a supermarket
☐ Pub (hotel or tavern)
☐ Nightclub
☐ Restaurant or café
☐ Internet
☐ Mail order
☐ Duty free shopping
☐ Other (*please specify in the space provided*)

---

35 If you have who bought take-away alcohol from a **bottle shop** in the past 12 months, please answer parts a) to e). *If not, go to Question 36.* Bottle shops include stand-alone and drive-through bottle shops but exclude liquor stores which are attached to, or part of, a supermarket.

a. In which suburb and/or postcode do you usually buy alcohol from a bottle shop?

____

b. In the last 12 months, how often did you usually buy alcohol at a bottle shop?

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

c. In the last 12 months, how much did you spend, on average, every time you purchased alcohol at a bottle shop?

____

d. How far are you usually prepared to travel to buy alcohol from a bottle shop? *Mark one response only.*

☐ less than 5km (less than 6 minutes driving in light traffic)
☐ 5km to 9km (6 to 12 minutes)
☐ 10km to 19km (13 to 25 minutes)
☐ 20km to 50km (26 minutes to an hour)
☐ more than 50km (more than an hour)
☐ distance doesn't influence which outlet I choose

e. Imagine you have learnt that a specific bottle shop is offering a price discount on a beverage that you usually purchase. How much **further** are you prepared to travel to receive such a discount? For each percentage discount offered below (i.e. 10%, 25%, 30%, 50%), tick the one box which best indicates how far you would be prepared to travel (i.e. no further, less than 5km further, 5km to 9km etc…). *For each row, mark one response only. If the price of alcohol has no impact on how far you will travel then select the 'no further' option for all rows.*

	Additional distance that I am prepared to travel					
Discount offered by a bottle shop	No further	Less than 5km further (*less than 6 minutes driving)*	5km to 9km (*6 to 12 minutes)*	10km to 19km (*13 to 25 minutes)*	20km to 50km *(26 minutes to an hour)*	More than 50km *(more than an hour)*
10%	☐	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐	☐
30%	☐	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐	☐

36 If you have who bought take-away alcohol from a **liquor store** attached to, or part of, a **supermarket** in the past 12 months, please answer parts a) to e). *If not, go to Question 37*.

a) In which suburb and/or postcode do you usually buy alcohol from a supermarket liquor store?

____

b) In the last 12 months, how often did you usually buy alcohol at a supermarket liquor store?

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

c) In the last 12 months, how much did you spend, on average, every time you purchased alcohol at a supermarket liquor store?

$____

d) How far are you usually prepared to travel to buy alcohol from a supermarket liquor store? *Mark one response only.*

☐ less than 5km (less than 6 minutes driving in light traffic)
☐ 5km to 9km (6 to 12 minutes)
☐ 10km to 19km (13 to 25 minutes)
☐ 20km to 50km (26 minutes to an hour)
☐ more than 50km (more than an hour)
☐ Distance doesn't influence which outlet I choose

e) Imagine you have learnt that a specific supermarket liquor store is offering a price discount on a beverage that you usually purchase. How much **further** are you prepared to travel to receive such a discount? For each percentage discount offered below (i.e. 10%, 25%, 30%, 50%), tick the one box which best indicates how far you would be prepared to travel. *For each row, mark one response only. If the price of alcohol has no impact on how far you will travel then select the 'no further' option for all rows.*

	Additional distance that I am prepared to travel					
Discount offered by a liquor store	No further	Less than 5km further (*less than 6 minutes driving)*	5km to 9km (*6 to 12 minutes)*	10km to 19km (*13 to 25 minutes)*	20km to 50km (*26 minutes to an hour)*	More than 50km (*more than an hour)*
10%	☐	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐	☐
30%	☐	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐	☐

37 If you have who bought alcohol from a **pub (hotel or tavern)** in order to drink it there in the past 12 months, please answer parts a) to e). *If not, go to Question 38.*

a. In which suburb and/or postcode do you usually buy alcohol from a pub?

____

b. In the last 12 months, how often did you usually buy alcohol at a pub?

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

c. In the last 12 months, how much did you spend, on average, every time you purchased alcohol at a pub?

____

d. How far are you usually prepared to travel to buy alcohol from a pub? *Mark one response only.*

☐ less than 5km (less than 6 minutes driving in light traffic)
☐ 5km to 9km (6 to 12 minutes)
☐ 10km to 19km (13 to 25 minutes)
☐ 20km to 50km (26 minutes to an hour)
☐ more than 50km (more than an hour)
☐ Distance doesn't influence which hotel/tavern I choose

e. Imagine you have learnt that a specific pub is offering a price discount on a beverage that you usually purchase. How much **further** are you prepared to travel to receive such a discount? For each percentage discount offered below (i.e. 10%, 25%, 30%, 50%), tick the one box which best indicates how far you would be prepared to travel. *For each row, mark one response only. If the price of alcohol has no impact on how far you will travel then select the 'no further' option for all rows.*

	Additional distance that I am prepared to travel					
Discount offered by a pub	No further	Less than 5km further (*less than 6 minutes driving)*	5km to 9km (*6 to 12 minutes)*	10km to 19km (*13 to 25 minutes)*	20km to 50km (*26 minutes to an hour)*	More than 50km (*more than an hour)*
10%	☐	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐	☐
30%	☐	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐	☐

38 If you have who bought alcohol from a **nightclub** in the past 12 months, please answer parts a) to e). *If not, go to Question 39.*

a. In which suburb and/or postcode do you buy alcohol from a nightclub most often?

____

b. In the last 12 months, how often did you usually buy alcohol at a nightclub?

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

c. In the past 12 months, how much did you spend, on average, every time you purchased alcohol at a nightclub?

____

d. How far are you usually prepared to travel to buy alcohol from a nightclub? *Mark one response only.*

☐ less than 5km (less than 6 minutes driving in light traffic)
☐ 5km to 9km (6 to 12 minutes)
☐ 10km to 19km (13 to 25 minutes)
☐ 20km to 50km (26 minutes to an hour)
☐ more than 50km (more an hour)
☐ Distance doesn't influence which nightclub I choose

e. Imagine you have learnt that a specific nightclub is offering a price discount on a beverage that you usually purchase. How much **further** are you prepared to travel to receive such a discount? For each percentage discount offered below (i.e. 10%, 25%, 30%, 50%), tick the one box which best indicates how far you would be prepared to travel. *For each row, mark one response only. If the price of alcohol has no impact on how far you will travel then select the 'no further' option for all rows.*

	Additional distance that I am prepared to travel					
Discount offered by a night-club	No further	Less than 5km further (*less than 6 minutes driving)*	5km to 9km *(6 to 12 minutes)*	10km to 19km (*13 to 25 minutes)*	20km to 50km (*26 minutes to an hour)*	More than 50km (*more than an hour)*
10%	☐	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐	☐
30%	☐	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐	☐

39 If you have who bought alcohol from a **restaurant** in the past 12 months, please answer parts a) to e). If not, you have completed the questionnaire.

a. In which suburb and/or postcode do you buy and consume alcohol with a meal such as at a restaurant or café most often?

____

b. In the past 12 months, how often did you usually buy alcohol at a restaurant or cafe?

☐ every day
☐ 5 to 6 days a week
☐ 3 to 4 days a week
☐ 1 to 2 days a week
☐ 2 to 3 days a month
☐ about 1 day a month
☐ less often than once a month

c. In the last 12 months, how much did you spend, on average, every time you purchased alcohol at a restaurant or cafe?

____

d. How far are you usually prepared to travel to a restaurant or café to buy a meal and alcoholic drinks? *Mark one response only.*

☐ less than 5km (less than 6 minutes driving in light traffic)
☐ 5km to 9km (6 to 12 minutes)
☐ 10km to 19km (13 to 25 minutes)
☐ 20km to 50km (26 minutes to an hour)
☐ more than 50km (more an hour)
☐ Distance doesn't influence my choice of restaurant or café.

e) Imagine you have learnt that a specific restaurant is offering a price discount on a beverage that you usually purchase. How much **further** are you prepared to travel to receive such a discount? For each percentage discount offered below (i.e. 10%, 25%, 30%, 50%), tick the one box which best indicates how far you would be prepared to travel. *For each row, mark one response only. If the price of alcohol has no impact on how far you will travel then select the 'no further' option for all rows.*

	Additional distance that I am prepared to travel					
Discount offered by a night-club	No further	Less than 5km further (*less than 6 minutes)*	5km to 9km (*6 to 12 minutes)*	10km to 19km (*13 to 25 minutes)*	20km to 50km (*26 minutes to an hour)*	More than 50km (*more than an hour)*
10%	☐	☐	☐	☐	☐	☐
25%	☐	☐	☐	☐	☐	☐
30%	☐	☐	☐	☐	☐	☐
50%	☐	☐	☐	☐	☐	☐

Thank you for completing the questionnaire.

10.9 Conversion factors used to calculate volumes of pure alcohol

Table 10.9 Conversion factors used to calculate volumes of pure alcohol wholesale purchases, in Perth Metropolitan Area from 2002 to 2010

Financial Year	High Alcohol Beer	Low Alcohol Beer	High Alcohol Wine	Low Alcohol Wine	All Spirits	Straight Spirits
2002/03	0.0476	0.0348	0.120	0.035	0.1193000	0.401
2003/04	0.0476	0.0348	0.121	0.035	0.11507477	0.405
2004/05	0.0476	0.0348	0.122	0.035	0.11137665	0.409
2005/06	0.0476	0.0348	0.124	0.035	0.1082720	0.413
2006/07	0.0476	0.0348	0.125	0.035	0.10575652	0.417
2007/08	0.0476	0.0348	0.126	0.035	0.10575652	0.417
2008/09	0.0476	0.0348	0.127	0.035	0.10575652	0.417
2009/10	0.0476	0.0348	0.127	0.035	0.10575652	0.417

10.10 Additional models for Phase four

10.10.1 Base models at postcode- and suburb-level

Table 10.10: Panel model results for counts of all outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of all outlets	1.011*	1.007	1.014	1.015*	1.011	1.020

* p<0.05

Table 10.11: Panel model results for counts of all outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of all outlets	1.013*	1.010	1.017	1.018*	1.013	1.022	1.011*	1.007	1.014	1.016*	1.011	1.021

* p<0.05

Table 10.12: Panel model results for counts of on-premise outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010*	1.007	1.014	1.015*	1.010	1.019

* p<0.05

Table 10.13: Panel model results for counts of on-premise outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.014*	1.011	1.018	1.019*	1.014	1.024	1.010*	1.006	1.014	1.015*	1.010	1.020

* p<0.05

Table 10.14**:** Panel model results for counts of off-premise outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of off-premise outlets	1.101*	1.068	1.136	1.125*	1.087	1.164

* p<0.05

Table 10.15 Panel model results for counts of off-premise outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of off-premise outlets	0.999	0.980	1.017	0.996	0.976	1.017	1.018*	1.006	1.031	1.018*	1.004	1.033

* p<0.05

Table 10.16: Panel model results for sales at all outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
All sales#/outlet	1.033*	1.002	1.065	1.017	0.981	1.055

#Sales in 10,000l * p<0.05

Table 10.17: Panel model results for sales at all outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
All sales#/outlet	1.044*	1.022	1.067	1.042*	1.017	1.067	1.019*	1.003	1.036	1.013	0.993	1.033

#Sales in 10,000l * p<0.05

Table 10.18: Panel model results for sales at on-premise outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet	0.996	0.961	1.033	0.980	0.939	1.023

#Sales in 10,000l * p<0.05

Table 10.19**:** Panel model results for sales at on-premise outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet	1.000	0.975	1.026	0.990	0.961	1.020	0.997	0.978	1.017	0.989	0.965	1.014

#Sales in 10,000l * p<0.05

Table 10.20**:** Panel model results for sales at off-premise outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Off-premise sales#/outlet	1.017*	1.006	1.028	1.014*	1.001	1.027

#Sales in 10,000l * p<0.05

Table 10.21 Panel model results for sales at off-premise outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Off-premise sales#/outlet	1.039*	1.023	1.054	1.042*	1.026	1.059	1.022*	1.010	1.034	1.022*	1.008	1.036

#Sales in 10,000l * p<0.05

Table 10.22: Panel model results for sales and counts of on- and off-premise outlets in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.003	1.011	1.010*	1.006	1.015
Count of off-premise outlets	1.065*	1.031	1.100	1.078*	1.040	1.118
On-premise sales#/outlet	1.007	0.972	1.044	0.992	0.952	1.034
Off-premise sales#/outlet	1.016*	1.005	1.028	1.013	0.999	1.026

#Sales in 10,000l * $p<0.05$

Table 10.23: Panel model results for sales and counts of on- and off-premise outlets in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.998	1.009	1.005	0.999	1.011	1.006*	1.002	1.011	1.007*	1.001	1.013
Count of off-premise outlets	1.235*	1.158	1.316	1.252*	1.170	1.341	1.080*	1.025	1.139	1.125*	1.057	1.196
On-premise sales#/outlet	1.027	0.996	1.059	1.025	0.989	1.063	0.999	0.972	1.027	0.998	0.965	1.033
Off-premise sales#/outlet	1.044*	1.029	1.060	1.046*	1.029	1.063	1.023*	1.011	1.034	1.024*	1.010	1.038

#Sales in 10,000l * $p<0.05$

Table 10.24: Panel model results for sales and counts of on- and off-premise outlets, adjusting for population over 15 years, in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.005*	1.003	1.008	1.006*	1.003	1.009
Count of off-premise outlets	0.997	0.975	1.019	1.000	0.977	1.025
On-premise sales#/outlet	1.008	0.977	1.040	0.994	0.959	1.032
Off-premise sales#/outlet	1.008	0.997	1.018	1.004	0.992	1.016
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ERP 15+: Estimated Resident Population 15 years and older

Table 10.25: Panel model results for sales and counts of on- and off-premise outlets, adjusting for population over 15 years, in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	1.000	1.008	1.004	1.000	1.008	1.003	0.999	1.007	1.003	0.999	1.008
Count of off-premise outlets	1.078*	1.020	1.140	1.077*	1.017	1.140	1.014	0.963	1.068	1.034	0.978	1.093
On-premise sales#/outlet	1.011	0.978	1.045	1.005	0.969	1.042	0.990	0.960	1.021	0.990	0.956	1.025
Off-premise sales#/outlet	1.028*	1.010	1.045	1.028*	1.009	1.046	1.014	1.000	1.028	1.016	1.000	1.032
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ERP 15+: Estimated Resident Population 15 years and older

Table 10.26: Panel model results for sales and counts of on- and off-premise outlets, adjusting for population over 15 years and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.006*	1.003	1.008	1.007*	1.004	1.009
Count of off-premise outlets	0.996	0.974	1.017	0.998	0.975	1.021
On-premise sales#/outlet	1.008	0.976	1.040	0.995	0.959	1.033
Off-premise sales#/outlet	1.009	0.999	1.019	1.006	0.994	1.019
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.952	0.893	1.019	0.961	0.893	1.036
SEIFA quartile 3	0.890*	0.811	0.986	0.878*	0.793	0.975
SEIFA quartile 4	0.883	0.780	1.024	0.837	0.733	0.968
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.27:Panel model results for sales and counts of on- and off-premise outlets, adjusting for population over 15 years and socio-economic status, in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries			Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.005*	1.001	1.009	1.005*	1.001	1.009	1.005*	1.001	1.008	1.005*	1.001	1.009
Count of off-premise outlets	1.083*	1.026	1.143	1.078*	1.020	1.139	1.012	0.965	1.061	1.025	0.975	1.078
On-premise sales#/outlet	1.010	0.977	1.044	1.005	0.969	1.042	0.992	0.963	1.021	0.992	0.959	1.025
Off-premise sales#/outlet	1.027*	1.010	1.046	1.028*	1.009	1.047	1.017*	1.003	1.032	1.019*	1.003	1.035
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.901	0.787	1.031	0.956	0.830	1.101	0.850*	0.747	0.966	0.898	0.778	1.035
SEIFA quartile 3	0.884	0.753	1.037	0.899	0.765	1.058	0.727*	0.629	0.841	0.745*	0.638	0.869
SEIFA quartile 4	0.782*	0.660	0.928	0.801*	0.676	0.949	0.632*	0.543	0.737	0.658*	0.562	0.771
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.28 Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.006*	1.004	1.009	1.007*	1.004	1.010
Count of off-premise outlets	0.989	0.968	1.011	0.991	0.970	1.015
On-premise sales#/outlet	1.012	0.981	1.044	1.000	0.965	1.037
Off-premise sales#/outlet	1.008	0.997	1.018	1.005	0.993	1.018
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.981	0.917	1.046	0.997	0.923	1.072
SEIFA quartile 3	0.962	0.871	1.060	0.965	0.864	1.072
SEIFA quartile 4	0.982	0.862	1.124	0.958	0.830	1.105
Unemployment%	1.001	0.995	1.007	0.998	0.991	1.005
Indigenous%	1.104*	1.052	1.162	1.104*	1.048	1.164
Young males%	0.980	0.961	1.010	0.977	0.951	1.100
Male/female%	0.998	0.993	1.004	0.999	0.991	1.004
Mean age	0.996	0.971	1.023	0.980	0.956	1.006
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.29: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	2002/03 to 2009/10						2004/05 to 2009/10					
	Night2 injuries			Weekend Night2 injuries								
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	0.999	1.006	1.002	0.999	1.006	1.004*	1.001	1.007	1.003	1.000	1.007
Count of off-premise outlets	1.003	0.955	1.054	1.017	0.967	1.070	0.993	0.951	1.037	1.016	0.969	1.064
On-premise sales#/outlet	0.993	0.962	1.024	0.988	0.955	1.023	0.986	0.960	1.014	0.985	0.955	1.017
Off-premise sales#/outlet	1.020*	1.004	1.037	1.019*	1.001	1.037	1.011	0.998	1.025	1.011	0.995	1.027
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.088	0.955	1.240	1.155*	1.001	1.331	1.025	0.901	1.166	1.076	0.926	1.251
SEIFA quartile 3	1.125	0.958	1.321	1.162	0.979	1.379	0.970	0.830	1.135	0.996	0.831	1.194
SEIFA quartile 4	1.168	0.970	1.408	1.202	0.986	1.465	0.940	0.785	1.126	0.974	0.790	1.199
Unemployment%	1.145*	1.109	1.182	1.143*	1.105	1.183	1.103*	1.066	1.141	1.099*	1.058	1.141
Indigenous%	1.068*	1.028	1.110	1.059*	1.016	1.104	1.061*	1.019	1.104	1.050*	1.003	1.099
Young males%	0.981	0.951	1.013	0.983	0.950	1.016	0.956	0.927	0.986	0.953*	0.922	0.985
Male/female%	0.998	0.997	1.000	0.999	0.997	1.001	1.001	0.999	1.003	1.001	0.999	1.004
Mean age	1.039*	1.020	1.058	1.025*	1.006	1.044	0.990	0.973	1.007	0.982	0.965	1.000
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.30: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.999	1.009	1.005	0.999	1.010
Count of off-premise outlets	0.909	0.836	0.988	0.909	0.822	1.005
On-premise sales#/outlet	1.003	0.986	1.019	1.002	0.981	1.025
Off-premise sales#/outlet	1.005	0.995	1.016	1.006	0.993	1.021
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.053	0.975	1.137	1.069	0.958	1.192
SEIFA quartile 3	0.893	0.745	1.071	0.941	0.754	1.175
SEIFA quartile 4	0.986	0.806	1.206	1.174	0.917	1.503
Unemployment%	0.979*	0.969	0.989	0.961*	0.952	0.970
Indigenous%	1.105	0.987	1.238	1.245*	1.109	1.399
Young males%	1.029	0.988	1.071	0.958*	0.926	0.991
Male/female%	0.994	0.981	1.008	0.985*	0.971	0.999
Mean age	0.989	0.932	1.049	0.984*	0.970	0.997
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.31: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
Within 1km of centroid	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.012*	1.007	1.017	1.010*	1.006	1.015	1.010*	1.004	1.016	1.008*	1.003	1.014
Count of off-premise outlets	0.929*	0.866	0.998	0.933	0.870	1.001	0.945	0.874	1.021	0.966	0.896	1.041
On-premise sales#/outlet	0.998	0.975	1.021	0.995	0.974	1.017	0.988	0.962	1.016	0.987	0.962	1.013
Off-premise sales#/outlet	1.010*	1.001	1.019	1.004	0.996	1.013	1.005	0.994	1.015	1.001	0.991	1.011
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.225*	1.026	1.464	1.178	0.990	1.402	1.285*	1.051	1.570	1.195	0.973	1.467
SEIFA quartile 3	1.319*	1.083	1.606	1.186	0.972	1.447	1.339*	1.072	1.672	1.152	0.910	1.457
SEIFA quartile 4	1.293*	1.029	1.624	1.135	0.902	1.428	1.327*	1.025	1.719	1.129	0.857	1.487
Unemployment%	1.084*	1.042	1.127	1.060*	1.015	1.107	1.088*	1.042	1.137	1.056*	1.005	1.109
Indigenous%	1.122*	1.072	1.175	1.133*	1.078	1.191	1.111*	1.055	1.170	1.121*	1.057	1.188
Young males%	0.995	0.959	1.033	0.962	0.925	1.000	0.992	0.953	1.033	0.958*	0.918	0.999
Male/female%	0.999	0.997	1.000	1.001	0.999	1.003	0.999	0.997	1.001	1.001	0.999	1.004
Mean age	1.037*	1.013	1.062	0.981	0.957	1.005	1.022	0.996	1.048	0.975	0.950	1.001
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.32: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	1.000	1.009	1.007*	1.002	1.012
Count of off-premise outlets	0.973	0.940	1.008	0.954*	0.917	0.992
On-premise sales#/outlet	1.020	0.997	1.043	1.020	0.994	1.047
Off-premise sales#/outlet	1.006	0.997	1.016	1.003	0.991	1.015
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.040	0.967	1.118	1.057	0.975	1.146
SEIFA quartile 3	1.064	0.934	1.213	1.084	0.937	1.255
SEIFA quartile 4	1.201*	1.026	1.407	1.197*	1.003	1.429
Unemployment%	0.970*	0.962	0.977	0.964*	0.955	0.973
Indigenous%	1.232*	1.116	1.361	1.236*	1.106	1.381
Young males%	1.068*	1.029	1.108	1.059*	1.016	1.105
Male/female%	0.975*	0.966	0.984	0.970*	0.958	0.981
Mean age	0.997	0.950	1.047	0.982	0.931	1.035
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.33: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
Within 2km of centroid	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.998	1.003	1.001	0.999	1.003	1.001	0.998	1.003	1.001	0.999	1.004
Count of off-premise outlets	1.030	0.991	1.070	1.012	0.974	1.050	1.029	0.987	1.074	1.015	0.973	1.058
On-premise sales#/outlet	0.998	0.982	1.014	0.999	0.984	1.014	0.994	0.975	1.013	0.993	0.975	1.012
Off-premise sales#/outlet	1.005	0.999	1.011	1.002	0.996	1.007	1.005	0.998	1.012	1.002	0.995	1.009
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.242*	1.028	1.500	1.204	0.998	1.452	1.286*	1.039	1.592	1.200	0.962	1.496
SEIFA quartile 3	1.456*	1.178	1.799	1.234	0.991	1.536	1.405*	1.108	1.781	1.145	0.886	1.479
SEIFA quartile 4	1.485*	1.152	1.915	1.268	0.975	1.649	1.441*	1.082	1.921	1.197	0.877	1.633
Unemployment%	1.082*	1.036	1.129	1.057*	1.007	1.109	1.075*	1.024	1.129	1.052	0.996	1.111
Indigenous%	1.157*	1.096	1.221	1.169*	1.101	1.241	1.148*	1.080	1.219	1.150*	1.074	1.233
Young males%	0.977	0.939	1.017	0.956*	0.916	0.998	0.979	0.938	1.023	0.955	0.911	1.002
Male/female%	0.998	0.997	1.000	1.001	0.999	1.003	0.999	0.997	1.001	1.001	0.999	1.004
Mean age	1.019	0.992	1.047	0.978	0.949	1.008	1.008	0.979	1.038	0.976	0.945	1.008
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.34: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at postcode-level, between 2004/05 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	0.994	0.980	1.009	0.987	0.971	1.003
On-premise sales#/outlet	1.044	0.971	1.123	1.079	0.997	1.167
Off-premise sales#/outlet	1.020*	1.007	1.034	1.016*	1.001	1.031
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.022	0.952	1.098	1.045	0.969	1.127
SEIFA quartile 3	1.048	0.935	1.174	1.054	0.932	1.191
SEIFA quartile 4	1.196*	1.039	1.377	1.184*	1.014	1.382
Unemployment%	0.966*	0.958	0.974	0.958*	0.949	0.967
Indigenous%	0.983	0.963	1.004	0.976*	0.956	0.995
Young males%	1.102*	1.065	1.141	1.093*	1.051	1.137
Male/female%	0.979*	0.971	0.987	0.975*	0.967	0.984
Mean age	1.031	0.981	1.084	1.025	0.972	1.080
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.35: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status, in Perth Metropolitan Area, at suburb-level, between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
Within 5km of centroid	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.001	1.000	1.002	1.001*	1.000	1.002	1.001	1.000	1.002	1.001*	1.000	1.002
Count of off-premise outlets	1.003	0.990	1.017	0.992	0.980	1.004	0.993	0.979	1.007	0.985	0.972	0.998
On-premise sales#/outlet	0.990	0.954	1.026	1.007	0.973	1.043	0.983	0.943	1.024	0.993	0.953	1.035
Off-premise sales#/outlet	1.007*	1.001	1.013	1.002	0.996	1.008	1.005	0.998	1.013	1.001	0.994	1.008
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.213*	1.003	1.467	1.210*	1.001	1.463	1.250*	1.010	1.548	1.185	0.950	1.479
SEIFA quartile 3	1.387*	1.119	1.719	1.239	0.993	1.546	1.372*	1.081	1.742	1.152	0.893	1.487
SEIFA quartile 4	1.417*	1.096	1.833	1.286	0.986	1.677	1.415*	1.060	1.888	1.223	0.897	1.667
Unemployment%	1.076*	1.030	1.123	1.058*	1.008	1.111	1.074*	1.023	1.127	1.058*	1.002	1.117
Indigenous%	1.159*	1.097	1.224	1.163*	1.095	1.236	1.142*	1.074	1.214	1.136*	1.059	1.218
Young males%	0.983	0.944	1.024	0.959	0.918	1.002	0.984	0.941	1.029	0.956	0.911	1.003
Male/female%	0.998	0.997	1.000	1.001	0.999	1.003	0.998	0.996	1.001	1.001	0.999	1.004
Mean age	1.025	0.997	1.053	0.985	0.955	1.016	1.014	0.984	1.045	0.984	0.952	1.017
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

10.10.2 Model stratifying by area from CBD

Table 10.36: Panel model results for sales and counts of on- and off-premise outlets, for postcodes and suburbs up 7km from the big CBD, adjusting for demographic and socio-economic status, at postcode- and suburb-level, in the Perth Metropolitan Area between 2002/03 and 2009/10

Postcode	Night2 injuries						Weekend Night2 injuries					
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.992	1.006	1.000	0.994	1.007	1.001	0.994	1.007	1.001	0.994	1.007
Count of off-premise outlets	0.948*	0.901	0.996	0.956	0.910	1.004	0.965	0.915	1.017	0.973	0.923	1.027
On-premise sales#/outlet	0.970	0.839	1.122	0.981	0.847	1.137	0.908	0.762	1.083	0.926	0.776	1.104
Off-premise sales#/outlet	0.989	0.961	1.017	0.977	0.949	1.007	0.978	0.944	1.013	0.973	0.937	1.010
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.750	0.554	1.015	0.734*	0.562	0.959	0.774	0.586	1.024	0.744*	0.571	0.970
SEIFA quartile 3	0.765	0.546	1.072	0.707*	0.516	0.969	0.774	0.559	1.072	0.736	0.531	1.019
SEIFA quartile 4	0.815	0.561	1.184	0.733	0.515	1.043	0.792	0.544	1.153	0.724	0.496	1.057
Unemployment%	0.995	0.977	1.013	1.010	0.975	1.046	0.989	0.966	1.013	0.993	0.946	1.042
Indigenous%	1.043	0.925	1.176	1.010	0.907	1.125	1.039	0.927	1.165	1.035	0.928	1.155
Young males%	1.018	0.964	1.074	0.994	0.948	1.042	1.004	0.956	1.054	0.991	0.947	1.037
Male/female%	1.015*	1.002	1.029	1.013*	1.001	1.026	1.016*	1.004	1.029	1.013*	1.001	1.025
Mean age	1.022	0.913	1.145	1.066	0.941	1.209	1.095	0.963	1.244	1.127	0.983	1.292
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Suburb				Night2 injuries				Weekend Night2 injuries				
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	not converge			1.009*	1.001	1.018	1.010*	1.001	1.018	1.007	0.999	1.016
Count of off-premise outlets				0.952	0.879	1.031	0.979	0.902	1.062	0.979	0.900	1.065
On-premise sales[#]/outlet				0.806	0.635	1.022	0.712*	0.544	0.930	0.841	0.646	1.095
Off-premise sales[#]/outlet				0.950	0.893	1.011	0.950	0.885	1.020	0.933	0.862	1.010
SEIFA quartile 1[^]				1.000			1.000			1.000		
SEIFA quartile 2				0.794	0.590	1.069	0.927	0.672	1.280	0.784	0.558	1.100
SEIFA quartile 3				0.861	0.619	1.197	0.878	0.607	1.270	0.805	0.560	1.157
SEIFA quartile 4				0.827	0.573	1.194	0.877	0.582	1.323	0.852	0.565	1.286
Unemployment%				1.040	0.966	1.118	1.092*	1.016	1.174	1.030	0.952	1.115
Indigenous%				1.056	0.959	1.163	1.004	0.918	1.099	1.073	0.973	1.184
Young males%				0.931*	0.889	0.975	0.929*	0.888	0.971	0.916*	0.871	0.962
Male/female%				1.001	0.997	1.005	1.001	0.998	1.005	1.002	0.997	1.007
Mean age				0.979	0.931	1.029	0.950*	0.907	0.995	0.956	0.909	1.004
ERP 15+				(exposure)			(exposure)			(exposure)		

[#]Sales in 10,000l [*] p<0.05 [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.37: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, for postcodes and suburbs up to 7km from the big CBD, adjusting for demographic and socio-economic status, at postcode- and suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Postcode	Night2 injuries						Weekend Night2 injuries					
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.992	0.978	1.006	0.989	0.976	1.002	0.987	0.973	1.002	0.988	0.973	1.002
Count of off-premise outlets	0.944	0.862	1.035	0.982	0.897	1.074	0.979	0.891	1.075	1.001	0.906	1.105
On-premise sales#/outlet	0.975	0.903	1.053	0.964	0.891	1.042	0.950	0.869	1.039	0.959	0.872	1.054
Off-premise sales#/outlet	0.976	0.951	1.002	0.970*	0.944	0.997	0.984	0.957	1.013	0.987	0.956	1.019
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.995	0.976	1.013	1.019	0.982	1.057	0.984	0.961	1.008	0.994	0.946	1.044
SEIFA quartile 3	1.294*	1.091	1.534	1.236*	1.035	1.477	1.199	0.999	1.439	1.140	0.931	1.396
SEIFA quartile 4	0.969	0.920	1.021	0.961	0.915	1.009	0.976	0.928	1.026	0.977	0.924	1.033
Unemployment%	1.016*	1.004	1.029	1.015*	1.004	1.026	1.018*	1.006	1.029	1.015*	1.003	1.027
Indigenous%	1.002	0.903	1.111	1.017	0.906	1.142	1.027	0.909	1.160	1.055	0.918	1.211
Young males%	1.233	0.820	1.853	1.125	0.758	1.669	1.097	0.736	1.637	0.936	0.609	1.438
Male/female%	1.371	0.840	2.236	1.191	0.717	1.980	1.121	0.670	1.874	0.933	0.526	1.656
Mean age	1.535	0.897	2.626	1.316	0.744	2.325	1.266	0.714	2.244	1.016	0.530	1.947
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Suburb	Night2 injuries						Weekend Night2 injuries					
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007	0.998	1.016	1.012*	1.002	1.022	1.011*	1.001	1.022	1.014*	1.003	1.026
Count of off-premise outlets	1.019	0.931	1.115	0.950	0.866	1.042	0.963	0.874	1.060	0.958	0.862	1.064
On-premise sales#/outlet	1.033	0.990	1.079	1.027	0.985	1.071	1.035	0.987	1.086	1.041	0.993	1.092
Off-premise sales#/outlet	1.006	0.974	1.040	0.995	0.961	1.031	1.022	0.982	1.064	1.022	0.979	1.067
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.151	0.795	1.667	1.053	0.692	1.602	1.416	0.864	2.319	0.421*	0.190	0.934
SEIFA quartile 3	1.177	0.792	1.751	1.177	0.736	1.881	1.413	0.834	2.393	0.412*	0.183	0.927
SEIFA quartile 4	1.098	0.712	1.693	1.164	0.698	1.942	1.415	0.793	2.524	0.384*	0.154	0.960
Unemployment%	1.036	0.978	1.097	0.994	0.938	1.054	1.000	0.941	1.063	0.975	0.906	1.049
Indigenous%	1.066	0.972	1.168	1.133*	1.026	1.250	1.120*	1.007	1.246	0.952	0.796	1.139
Young males%	0.948*	0.911	0.985	0.939*	0.900	0.980	0.929*	0.889	0.971	0.938*	0.889	0.990
Male/female%	1.001	0.998	1.004	1.004	1.000	1.008	1.001	0.998	1.005	1.005	1.000	1.011
Mean age	0.996	0.950	1.045	0.989	0.944	1.035	0.972	0.929	1.017	0.959	0.912	1.007
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.38: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, for postcodes and suburbs up to 7km from the big CBD, adjusting for demographic and socio-economic status, at postcode- and suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Postcode	Night2 injuries						Weekend Night2 injuries					
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.984	1.016	1.002	0.986	1.018	1.004	0.987	1.022	1.005	0.987	1.023
Count of off-premise outlets	0.955	0.908	1.005	0.952	0.902	1.004	0.943*	0.890	0.999	0.945	0.888	1.004
On-premise sales#/outlet	0.971	0.910	1.036	0.973	0.911	1.040	0.989	0.922	1.060	0.989	0.922	1.061
Off-premise sales#/outlet	0.979	0.951	1.007	0.978	0.949	1.008	0.959*	0.926	0.994	0.965	0.928	1.004
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.999	0.981	1.018	1.019	0.984	1.056	0.995	0.973	1.018	1.002	0.956	1.051
SEIFA quartile 3	1.064	0.952	1.190	1.035	0.929	1.153	1.098	0.985	1.224	1.093	0.976	1.223
SEIFA quartile 4	0.989	0.938	1.044	0.967	0.920	1.018	0.968	0.921	1.018	0.960	0.914	1.010
Unemployment%	1.018*	1.005	1.031	1.017*	1.005	1.030	1.019*	1.008	1.031	1.017*	1.005	1.029
Indigenous%	1.016	0.909	1.136	1.047	0.923	1.186	1.071	0.945	1.212	1.088	0.950	1.247
Young males%	0.692*	0.513	0.934	0.690*	0.521	0.913	0.738	0.559	0.973	0.736*	0.564	0.961
Male/female%	0.763	0.547	1.065	0.739	0.529	1.033	0.872	0.630	1.207	0.862	0.612	1.212
Mean age	0.823	0.570	1.187	0.808	0.555	1.178	0.981	0.675	1.427	0.969	0.645	1.456
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Suburb	Night2 injuries					Weekend Night2 injuries					
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10		2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.999	1.009	Did not converge		1.006*	1.001	1.012	1.009*	1.003	1.015
Count of off-premise outlets	1.006	0.961	1.052			0.979	0.930	1.031	0.948	0.896	1.002
On-premise sales#/outlet	1.085	0.987	1.193			1.130*	1.020	1.252	1.118*	1.006	1.243
Off-premise sales#/outlet	0.992	0.970	1.015			0.995	0.967	1.024	0.995	0.965	1.027
SEIFA quartile 1^	1.000					1.000			1.000		
SEIFA quartile 2	1.000					1.000			1.000		
SEIFA quartile 3	1.190	0.824	1.719			1.515	0.937	2.450	1.343	0.791	2.281
SEIFA quartile 4	1.186	0.799	1.761			1.462	0.872	2.450	1.632	0.892	2.985
Unemployment%	1.139	0.736	1.761			1.554	0.875	2.759	1.924	0.989	3.744
Indigenous%	1.024	0.976	1.074			1.009	0.957	1.064	0.985	0.923	1.050
Young males%	1.090*	1.003	1.186			1.130*	1.025	1.247	1.222*	1.092	1.368
Male/female%	0.954*	0.920	0.990			0.932*	0.893	0.973	0.905*	0.860	0.953
Mean age	1.001	0.998	1.004			1.002	0.998	1.005	1.005	1.000	1.011
ERP 15+	0.994	0.955	1.035			0.974	0.935	1.014	0.983	0.939	1.030
	(exposure)					(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.39: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, for postcodes and suburbs up to 7km of the big CBD, adjusting for demographic and socio-economic status, at postcode- and suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

Postcode	Night2 injuries						Weekend Night2 injuries					
Big CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.002	1.000	0.999	1.001	1.000	0.999	1.002
Count of off-premise outlets	0.984	0.964	1.005	0.977	0.955	1.000	0.987	0.966	1.008	0.983	0.963	1.005
On-premise sales#/outlet	0.870	0.603	1.255	0.733	0.503	1.067	0.555*	0.355	0.867	0.481*	0.307	0.754
Off-premise sales#/outlet	0.961	0.887	1.041	0.931	0.858	1.010	0.905*	0.821	0.997	0.888*	0.805	0.981
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.997	0.979	1.016	1.022	0.986	1.060	0.985	0.964	1.008	1.003	0.958	1.050
SEIFA quartile 3	1.013	0.895	1.146	0.971	0.866	1.088	1.044	0.936	1.165	1.036	0.940	1.142
SEIFA quartile 4	0.980	0.920	1.043	0.950	0.892	1.011	0.969	0.916	1.025	0.959	0.908	1.013
Unemployment%	1.023*	1.007	1.040	1.020*	1.002	1.038	1.021*	1.004	1.038	1.012	0.995	1.029
Indigenous%	1.027	0.914	1.155	1.059	0.929	1.207	1.086	0.953	1.238	1.110	0.969	1.272
Young males%	0.773	0.561	1.064	0.752	0.560	1.009	0.771	0.581	1.021	0.724	0.556	0.944
Male/female%	0.819	0.564	1.189	0.752	0.515	1.097	0.777	0.537	1.126	0.693	0.477	1.009
Mean age	0.828	0.546	1.257	0.725	0.472	1.113	0.745	0.488	1.138	0.632*	0.413	0.968
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Suburb	Night2 injuries						Weekend Night2 injuries					
CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	1.000	1.001	1.000	0.999	1.001	1.001	1.000	1.002
Count of off-premise outlets	1.023*	1.005	1.042	1.015	0.996	1.034	1.016	0.997	1.036	1.007	0.984	1.029
On-premise sales#/outlet	1.225*	1.050	1.429	1.163	0.999	1.354	1.285*	1.073	1.537	1.237*	1.027	1.490
Off-premise sales#/outlet	0.995	0.964	1.027	0.982	0.951	1.014	0.993	0.956	1.031	0.983	0.944	1.024
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.461	0.996	2.143	1.299	0.871	1.938	1.813*	1.128	2.913	1.505	0.906	2.501
SEIFA quartile 3	1.423	0.941	2.151	1.459	0.927	2.296	1.747*	1.045	2.921	1.863*	1.035	3.354
SEIFA quartile 4	1.501	0.961	2.346	1.578	0.971	2.564	1.920*	1.104	3.340	2.151*	1.147	4.033
Unemployment%	1.000	0.952	1.050	0.961	0.913	1.013	0.986	0.931	1.044	0.946	0.886	1.010
Indigenous%	1.204*	1.095	1.323	1.282*	1.164	1.411	1.225*	1.097	1.368	1.336*	1.185	1.507
Young males%	0.984	0.944	1.026	0.993	0.948	1.041	0.961	0.914	1.011	0.947	0.895	1.004
Male/female%	1.003*	1.001	1.005	1.007*	1.004	1.010	1.002	0.999	1.005	1.006*	1.002	1.010
Mean age	1.020	0.974	1.069	1.028	0.979	1.079	0.992	0.944	1.042	0.997	0.942	1.054
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.40: Panel model results for sales and counts of on- and off-premise outlets, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.008*	1.002	1.014	1.010*	1.005	1.015
Count of off-premise outlets	0.928*	0.880	0.978	0.943*	0.890	0.999
On-premise sales#/outlet	1.019	0.870	1.194	0.977	0.808	1.181
Off-premise sales#/outlet	0.974	0.944	1.006	0.965	0.928	1.003
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.865	0.631	1.184	0.855	0.626	1.168
SEIFA quartile 3	0.873	0.617	1.235	0.918	0.643	1.310
SEIFA quartile 4	0.877	0.592	1.300	0.834	0.548	1.271
Unemployment%	1.009	0.974	1.045	0.992	0.947	1.038
Indigenous%	1.108	0.980	1.253	1.124	0.991	1.275
Young males%	1.018	0.958	1.080	0.992	0.938	1.048
Male/female%	1.013*	1.003	1.024	1.013*	1.003	1.024
Mean age	1.091	0.952	1.250	1.156	0.998	1.340
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	0.996	1.010	1.004	0.997	1.012
Count of off-premise outlets	0.994	0.964	1.025	0.990	0.960	1.022
On-premise sales#/outlet	1.007	0.972	1.043	0.998	0.957	1.040
Off-premise sales#/outlet	1.001	0.984	1.019	1.000	0.980	1.020
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.010	0.895	1.139	0.968	0.843	1.111
SEIFA quartile 3	0.905	0.725	1.129	0.892	0.701	1.135
SEIFA quartile 4	0.943	0.738	1.206	0.888	0.685	1.151
Unemployment%	1.002	0.996	1.009	1.001	0.993	1.008
Indigenous%	1.113*	1.025	1.208	1.072	0.986	1.167
Young males%	0.934*	0.892	0.977	0.927*	0.885	0.971
Male/female%	1.012	0.998	1.027	1.014	1.000	1.029
Mean age	1.008	0.973	1.044	0.994	0.960	1.029
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries			Weekend Night2 injuries		
15km+ from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.013*	1.007	1.019	1.012*	1.005	1.019
Count of off-premise outlets	0.981	0.953	1.010	0.983	0.953	1.014
On-premise sales#/outlet	1.066	0.994	1.142	1.076	0.998	1.160
Off-premise sales#/outlet	1.011	0.997	1.026	1.009	0.994	1.025
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.964	0.887	1.048	1.014	0.924	1.113
SEIFA quartile 3	0.952	0.843	1.074	0.987	0.864	1.128
SEIFA quartile 4	0.979	0.823	1.163	0.993	0.825	1.195
Unemployment%	0.993	0.975	1.011	0.984	0.965	1.004
Indigenous%	1.153*	1.080	1.230	1.139*	1.060	1.224
Young males%	0.985	0.955	1.016	0.982	0.950	1.016
Male/female%	0.986*	0.978	0.994	0.988*	0.979	0.997
Mean age	0.996	0.959	1.034	0.990	0.949	1.034
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.41: Panel model results for sales and counts of on- and off-premise outlets, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.018*	1.011	1.025	1.018*	1.011	1.024	1.016*	1.008	1.023	1.014*	1.006	1.021
Count of off-premise outlets	0.950	0.881	1.024	0.922*	0.853	0.997	0.967	0.892	1.048	0.955	0.880	1.036
On-premise sales#/outlet	0.777*	0.623	0.968	0.867	0.688	1.092	0.783	0.610	1.006	0.909	0.706	1.169
Off-premise sales#/outlet	0.950	0.898	1.006	0.929*	0.874	0.988	0.939	0.875	1.007	0.911*	0.842	0.986
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.061	0.823	1.366	0.958	0.717	1.281	1.051	0.765	1.442	0.919	0.660	1.281
SEIFA quartile 3	1.049	0.773	1.424	0.986	0.704	1.379	0.946	0.653	1.371	0.902	0.622	1.308
SEIFA quartile 4	0.973	0.685	1.383	0.927	0.634	1.354	0.911	0.599	1.386	0.909	0.595	1.388
Unemployment%	1.067	0.997	1.142	0.994	0.928	1.065	1.044	0.978	1.115	0.979	0.913	1.051
Indigenous%	1.064	0.972	1.165	1.121*	1.016	1.237	1.049	0.957	1.151	1.131*	1.023	1.250
Young males%	0.950*	0.909	0.994	0.962	0.918	1.008	0.948	0.907	0.990	0.940*	0.895	0.987
Male/female%	1.003*	1.001	1.005	1.005*	1.002	1.009	1.002	1.000	1.005	1.005*	1.001	1.009
Mean age	0.978	0.930	1.027	0.987	0.934	1.042	0.946	0.901	0.992	0.956	0.907	1.007
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
7km to 15km from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.988	0.976	1.000	1.018*	1.008	1.028	1.001	0.988	1.015	1.023*	1.014	1.032
Count of off-premise outlets	1.006	0.921	1.098	0.952	0.901	1.007	0.996	0.916	1.084	0.953	0.907	1.001
On-premise sales#/outlet	0.975	0.939	1.012	0.990	0.958	1.023	0.968	0.925	1.013	0.989	0.955	1.025
Off-premise sales#/outlet	1.013	0.981	1.045	1.008	0.980	1.037	1.005	0.969	1.043	1.008	0.978	1.039
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.057	0.864	1.292	1.134	0.921	1.396	1.226	0.977	1.538	1.134	0.923	1.394
SEIFA quartile 3	0.951	0.719	1.256	1.075	0.833	1.385	1.151	0.855	1.551	1.123	0.874	1.443
SEIFA quartile 4	0.879	0.642	1.204	0.958	0.715	1.284	1.025	0.733	1.432	0.973	0.730	1.298
Unemployment%	1.078*	1.017	1.143	1.076*	1.018	1.137	1.077*	1.010	1.149	1.052	0.996	1.111
Indigenous%	1.074*	1.003	1.151	1.117*	1.041	1.199	1.093*	1.013	1.180	1.115*	1.040	1.196
Young males%	1.023	0.964	1.087	0.936*	0.894	0.980	1.004	0.944	1.068	0.941*	0.900	0.982
Male/female%	0.997*	0.994	0.999	1.000	0.996	1.003	0.998	0.995	1.000	1.000	0.997	1.004
Mean age	1.056*	1.015	1.099	0.986	0.958	1.014	1.027	0.987	1.069	0.972*	0.946	0.998
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
15km+ from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.985	1.024	1.004	0.988	1.020	1.001	0.981	1.021	0.999	0.982	1.016
Count of off-premise outlets	1.019	0.932	1.114	1.007	0.938	1.082	1.027	0.938	1.124	1.024	0.947	1.107
On-premise sales#/outlet	1.053	0.984	1.128	1.005	0.955	1.058	1.053	0.984	1.127	1.013	0.957	1.072
Off-premise sales#/outlet	1.012	0.988	1.037	1.009	0.995	1.024	1.009	0.985	1.034	1.005	0.988	1.022
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.996	0.798	1.242	0.961	0.821	1.125	1.047	0.836	1.310	1.031	0.852	1.249
SEIFA quartile 3	1.149	0.864	1.527	0.890	0.718	1.103	1.158	0.870	1.541	0.986	0.763	1.275
SEIFA quartile 4	1.064	0.769	1.471	0.777*	0.607	0.993	1.076	0.778	1.489	0.864	0.647	1.153
Unemployment%	1.196*	1.144	1.250	1.143*	1.092	1.196	1.206*	1.151	1.263	1.166*	1.109	1.226
Indigenous%	1.036	0.978	1.097	1.003	0.953	1.055	1.014	0.956	1.075	0.986	0.930	1.045
Young males%	1.019	0.969	1.072	0.993	0.952	1.037	1.026	0.975	1.080	1.001	0.954	1.051
Male/female%	0.998	0.995	1.001	1.000	0.998	1.003	0.999	0.995	1.002	1.002	0.998	1.005
Mean age	1.030*	1.002	1.058	0.994	0.973	1.016	1.023	0.996	1.050	0.991	0.969	1.015
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.42: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.003	1.011	1.009*	1.005	1.014
Count of off-premise outlets	0.931	0.851	1.018	0.916	0.829	1.011
On-premise sales#/outlet	1.013	0.934	1.098	1.016	0.921	1.121
Off-premise sales#/outlet	0.973	0.945	1.002	0.989	0.955	1.024
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.270	0.798	2.021	1.115	0.668	1.862
SEIFA quartile 3	1.457	0.839	2.528	1.305	0.699	2.438
SEIFA quartile 4	1.532	0.838	2.799	1.317	0.654	2.652
Unemployment%	1.019	0.983	1.055	0.995	0.950	1.042
Indigenous%	1.325*	1.105	1.588	1.265*	1.022	1.566
Young males%	0.979	0.923	1.039	0.969	0.909	1.033
Male/female%	1.012*	1.002	1.022	1.011	1.000	1.022
Mean age	1.059	0.936	1.200	1.092	0.941	1.267
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.994	0.973	1.015	0.987	0.965	1.009
Count of off-premise outlets	1.148*	1.037	1.272	1.130*	1.017	1.255
On-premise sales#/outlet	0.993	0.976	1.010	0.987	0.967	1.008
Off-premise sales#/outlet	1.003	0.987	1.019	0.997	0.977	1.017
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.090	0.921	1.291	1.046	0.851	1.287
SEIFA quartile 3	0.938	0.688	1.277	0.846	0.598	1.198
SEIFA quartile 4	1.040	0.736	1.470	0.914	0.623	1.339
Unemployment%	0.973	0.937	1.011	0.953	0.909	1.000
Indigenous%	1.164*	1.023	1.324	1.085	0.950	1.240
Young males%	0.924*	0.880	0.971	0.905*	0.859	0.953
Male/female%	1.010	0.996	1.025	1.013	0.999	1.028
Mean age	0.990	0.945	1.036	0.987	0.942	1.034
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
15km+ from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.964*	0.944	0.984	0.968*	0.944	0.993
Count of off-premise outlets	1.104	0.999	1.220	1.076	0.948	1.221
On-premise sales#/outlet	0.960	0.910	1.013	0.965	0.905	1.028
Off-premise sales#/outlet	1.005	0.990	1.020	1.006	0.989	1.024
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.007	0.929	1.091	1.066	0.975	1.164
SEIFA quartile 3	0.887	0.721	1.090	0.996	0.776	1.279
SEIFA quartile 4	0.874	0.709	1.078	0.963	0.747	1.241
Unemployment%	1.009	0.990	1.028	1.001	0.978	1.024
Indigenous%	1.142*	1.011	1.289	1.177*	1.014	1.366
Young males%	0.989	0.956	1.022	0.986	0.947	1.027
Male/female%	1.044*	1.028	1.061	1.039*	1.020	1.060
Mean age	1.058	0.999	1.121	1.053	0.981	1.131
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.43: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010*	1.006	1.015	Did not converge			1.011*	1.006	1.016	1.010*	1.006	1.015
Count of off-premise outlets	1.004	0.925	1.090				0.962	0.885	1.045	0.933	0.857	1.016
On-premise sales#/outlet	1.041	0.995	1.089				1.040	0.990	1.093	1.031	0.981	1.084
Off-premise sales#/outlet	1.011	0.978	1.044				1.026	0.986	1.067	1.016	0.974	1.060
SEIFA quartile 1^	1.000						1.000			1.000		
SEIFA quartile 2	1.320	0.918	1.899				1.612*	1.014	2.563	1.360	0.815	2.270
SEIFA quartile 3	1.326	0.894	1.967				1.596	0.966	2.635	1.676	0.934	3.007
SEIFA quartile 4	1.225	0.795	1.887				1.563	0.897	2.723	1.790	0.940	3.408
Unemployment%	1.008	0.952	1.067				0.974	0.920	1.031	0.944	0.886	1.005
Indigenous%	1.116*	1.019	1.222				1.158*	1.047	1.280	1.244*	1.114	1.390
Young males%	0.970	0.930	1.011				0.945*	0.903	0.989	0.919*	0.875	0.964
Male/female%	1.003*	1.001	1.005				1.002	1.000	1.005	1.006*	1.002	1.010
Mean age	1.004	0.954	1.057				0.976	0.931	1.023	0.978	0.929	1.031
ERP 15+	(exposure)						(exposure)			(exposure)		

#Sales in 10,000l *$p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
7km to 15km from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.031*	1.003	1.060	1.030*	1.003	1.058	1.029	1.000	1.059	1.024	0.998	1.051
Count of off-premise outlets	0.810*	0.698	0.941	0.829*	0.712	0.964	0.869	0.746	1.012	0.924	0.803	1.062
On-premise sales#/outlet	0.989	0.963	1.015	0.987	0.962	1.014	0.978	0.945	1.011	0.977	0.945	1.010
Off-premise sales#/outlet	1.005	0.991	1.020	0.999	0.984	1.015	0.994	0.977	1.010	0.991	0.973	1.009
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.527*	1.081	2.157	1.333	0.886	2.005	1.522*	1.034	2.239	1.180	0.771	1.805
SEIFA quartile 3	1.558*	1.099	2.208	1.381	0.921	2.069	1.467	0.996	2.162	1.125	0.729	1.734
SEIFA quartile 4	1.484*	1.004	2.194	1.331	0.839	2.111	1.364	0.875	2.127	1.025	0.615	1.710
Unemployment%	1.088*	1.022	1.159	1.084	0.997	1.177	1.094*	1.017	1.176	1.071	0.982	1.169
Indigenous%	1.196*	1.092	1.310	1.184*	1.064	1.318	1.157*	1.046	1.279	1.122*	1.002	1.257
Young males%	0.991	0.930	1.057	0.939	0.873	1.009	0.994	0.927	1.065	0.953	0.887	1.024
Male/female%	0.996*	0.994	0.999	0.999	0.995	1.002	0.998	0.995	1.001	1.000	0.996	1.004
Mean age	1.014	0.969	1.062	0.981	0.931	1.034	1.021	0.972	1.072	0.996	0.946	1.048
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
15km+ from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.966	1.033	1.005	0.982	1.027	0.983	0.950	1.017	0.988	0.963	1.012
Count of off-premise outlets	0.927	0.815	1.054	0.975	0.888	1.070	0.964	0.844	1.101	1.005	0.908	1.113
On-premise sales#/outlet	1.068	0.975	1.169	1.069*	1.006	1.135	1.090	0.996	1.192	1.079*	1.009	1.153
Off-premise sales#/outlet	1.018*	1.002	1.033	1.007	0.997	1.016	1.012	0.997	1.028	1.002	0.991	1.013
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.122	0.849	1.483	1.212*	1.004	1.464	1.191	0.906	1.567	1.262*	1.018	1.566
SEIFA quartile 3	1.322	0.897	1.947	1.219	0.945	1.573	1.442	0.983	2.115	1.332	0.996	1.783
SEIFA quartile 4	1.111	0.739	1.669	0.988	0.748	1.305	1.216	0.808	1.832	1.088	0.791	1.496
Unemployment%	1.111*	1.037	1.190	1.093*	1.039	1.150	1.144*	1.068	1.226	1.119*	1.057	1.185
Indigenous%	1.082	1.000	1.171	1.083*	1.022	1.148	1.042	0.963	1.128	1.053	0.984	1.126
Young males%	1.058	0.989	1.132	1.025	0.974	1.079	1.062	0.992	1.137	1.035	0.978	1.096
Male/female%	0.999	0.995	1.003	1.003	0.999	1.007	0.999	0.995	1.004	1.004	0.999	1.008
Mean age	1.051*	1.015	1.089	0.994	0.970	1.018	1.040*	1.004	1.077	0.992	0.966	1.019
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.44: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010*	1.004	1.015	1.012*	1.006	1.018
Count of off-premise outlets	0.964	0.926	1.003	0.963	0.923	1.004
On-premise sales#/outlet	0.963	0.899	1.032	0.993	0.919	1.074
Off-premise sales#/outlet	0.974	0.945	1.003	0.969	0.932	1.006
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.684*	0.487	0.960	0.719	0.511	1.011
SEIFA quartile 3	0.721	0.500	1.040	0.829	0.569	1.207
SEIFA quartile 4	0.708	0.477	1.050	0.783	0.516	1.190
Unemployment%	1.022*	1.007	1.038	1.013	0.994	1.033
Indigenous%	1.074	0.950	1.213	1.089	0.956	1.240
Young males%	0.986	0.932	1.044	0.967	0.913	1.023
Male/female%	1.015*	1.003	1.026	1.010	0.999	1.021
Mean age	1.048	0.915	1.199	1.143	0.984	1.327
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.008	0.990	1.027	1.005	0.985	1.025
Count of off-premise outlets	1.032	0.989	1.077	1.026	0.980	1.074
On-premise sales#/outlet	0.999	0.969	1.030	1.002	0.966	1.039
Off-premise sales#/outlet	1.002	0.987	1.016	0.998	0.982	1.015
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.032	0.912	1.168	0.989	0.851	1.150
SEIFA quartile 3	0.904	0.721	1.132	0.901	0.699	1.162
SEIFA quartile 4	0.985	0.775	1.252	0.948	0.726	1.238
Unemployment%	0.994	0.981	1.007	0.992	0.976	1.008
Indigenous%	1.161*	1.071	1.259	1.108*	1.016	1.208
Young males%	0.951*	0.909	0.995	0.938*	0.894	0.985
Male/female%	1.007	0.996	1.018	1.011*	1.000	1.021
Mean age	0.989	0.956	1.023	0.981	0.948	1.014
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries	
15km+ from CBD	IRR	95% CI		IRR	95% CI
Count of on-premise outlets	0.990	0.964	1.016	Not converge	
Count of off-premise outlets	1.009	0.941	1.082		
On-premise sales#/outlet	1.031	0.998	1.065		
Off-premise sales#/outlet	1.007	0.992	1.021		
SEIFA quartile 1	1.000				
SEIFA quartile 2	1.039	0.953	1.132		
SEIFA quartile 3	1.049	0.899	1.225		
SEIFA quartile 4	1.193	0.973	1.463		
Unemployment%	1.004	0.991	1.018		
Indigenous%	1.230*	1.088	1.391		
Young males%	1.006	0.955	1.059		
Male/female%	1.010	0.985	1.037		
Mean age	1.030	0.972	1.090		
ERP 15+	(exposure)				

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.45: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.002	1.000	1.004	1.002*	1.001	1.004	1.002	1.000	1.004	1.003	1.000	1.005
Count of off-premise outlets	1.018	0.983	1.055	1.004	0.972	1.037	1.007	0.972	1.042	0.994	0.958	1.032
On-premise sales#/outlet	1.093	0.982	1.217	1.070	0.968	1.182	1.129*	1.011	1.262	1.107	0.987	1.240
Off-premise sales#/outlet	0.992	0.968	1.017	0.984	0.959	1.009	0.994	0.964	1.024	0.993	0.960	1.026
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.399	0.964	2.031	1.256	0.842	1.874	1.726*	1.078	2.761	1.453	0.876	2.408
SEIFA quartile 3	1.380	0.919	2.072	1.426	0.904	2.250	1.661	0.995	2.773	1.809*	1.009	3.245
SEIFA quartile 4	1.352	0.868	2.106	1.444	0.879	2.372	1.733	0.989	3.039	2.020*	1.069	3.817
Unemployment%	1.002	0.947	1.061	0.959	0.907	1.013	0.979	0.925	1.037	0.942	0.882	1.006
Indigenous%	1.149*	1.045	1.262	1.206*	1.098	1.325	1.172*	1.058	1.299	1.271*	1.136	1.421
Young males%	0.978	0.936	1.022	0.974	0.931	1.018	0.952*	0.907	0.999	0.930*	0.883	0.980
Male/female%	1.003*	1.001	1.005	1.007*	1.004	1.010	1.002	0.999	1.005	1.006*	1.002	1.010
Mean age	0.998	0.949	1.049	0.994	0.948	1.041	0.970	0.928	1.014	0.972	0.925	1.022
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
7km to 15km from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.980*	0.968	0.992	0.990	0.978	1.003	0.986	0.972	1.000	0.997	0.983	1.011
Count of off-premise outlets	1.079	0.985	1.182	1.032	0.940	1.133	1.099	0.988	1.222	1.042	0.942	1.154
On-premise sales#/outlet	0.993	0.977	1.009	0.992	0.975	1.009	0.988	0.967	1.009	0.987	0.965	1.009
Off-premise sales#/outlet	1.002	0.996	1.008	0.999	0.993	1.006	1.003	0.995	1.011	1.000	0.991	1.008
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.289	0.830	2.001	1.307	0.746	2.289	1.509	0.933	2.442	1.259	0.741	2.137
SEIFA quartile 3	1.279	0.821	1.990	1.345	0.788	2.296	1.351	0.833	2.193	1.182	0.710	1.970
SEIFA quartile 4	1.195	0.740	1.930	1.331	0.748	2.368	1.265	0.744	2.150	1.155	0.648	2.057
Unemployment%	1.078*	1.006	1.156	1.091	0.992	1.199	1.070	0.986	1.162	1.082	0.977	1.200
Indigenous%	1.158*	1.040	1.289	1.179*	1.038	1.339	1.153*	1.024	1.298	1.133	0.994	1.291
Young males%	1.003	0.931	1.082	0.937	0.860	1.021	1.015	0.932	1.105	0.952	0.873	1.039
Male/female%	0.996*	0.993	0.999	0.997	0.994	1.001	0.998	0.995	1.001	1.000	0.996	1.004
Mean age	1.044	0.985	1.106	0.985	0.924	1.050	1.030	0.967	1.098	0.983	0.924	1.046
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
15km+ from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.001	0.992	1.010	1.003	0.996	1.010	1.000	0.990	1.009	1.001	0.993	1.009
Count of off-premise outlets	1.175*	1.082	1.277	1.069	0.998	1.146	1.184*	1.091	1.284	1.076	0.995	1.164
On-premise sales#/outlet	1.006	0.945	1.071	1.042	0.993	1.094	1.026	0.965	1.089	1.050	0.996	1.107
Off-premise sales#/outlet	1.027*	1.007	1.048	1.011	0.996	1.027	1.022*	1.002	1.042	1.006	0.990	1.023
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.989	0.747	1.310	1.175	0.960	1.438	1.009	0.767	1.327	1.170	0.934	1.465
SEIFA quartile 3	1.164	0.827	1.638	1.120	0.856	1.467	1.181	0.843	1.654	1.139	0.842	1.543
SEIFA quartile 4	0.586*	0.405	0.848	0.756	0.535	1.069	0.606*	0.420	0.874	0.781	0.519	1.176
Unemployment%	1.060	0.985	1.139	1.051	0.993	1.113	1.078*	1.003	1.158	1.079*	1.013	1.150
Indigenous%	1.089*	1.002	1.184	1.116*	1.041	1.196	1.068	0.984	1.160	1.083*	1.003	1.170
Young males%	1.105*	1.027	1.189	1.084*	1.012	1.160	1.128*	1.049	1.213	1.108*	1.026	1.196
Male/female%	0.997	0.993	1.002	1.002	0.998	1.007	0.997	0.992	1.001	1.003	0.998	1.007
Mean age	1.077*	1.041	1.115	1.020	0.989	1.052	1.063*	1.028	1.100	1.015	0.981	1.049
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.46: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
CBD to 7km	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	Not converge		
Count of off-premise outlets	0.983	0.958	1.010			
On-premise sales#/outlet	0.690*	0.476	0.999			
Off-premise sales#/outlet	0.951	0.877	1.031			
SEIFA quartile 1^	1.000					
SEIFA quartile 2	0.934	0.611	1.428			
SEIFA quartile 3	0.996	0.632	1.569			
SEIFA quartile 4	0.964	0.590	1.573			
Unemployment%	1.019*	1.002	1.036			
Indigenous%	1.067	0.912	1.248			
Young males%	0.985	0.913	1.062			
Male/female%	1.033*	1.017	1.050			
Mean age	0.969	0.832	1.129			
ERP 15+	(exposure)					

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
7km to 15km from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003*	1.001	1.006	1.001	0.999	1.004
Count of off-premise outlets	0.997	0.986	1.009	0.997	0.985	1.010
On-premise sales#/outlet	0.907	0.809	1.017	0.907	0.797	1.034
Off-premise sales#/outlet	1.011	0.985	1.039	0.999	0.968	1.031
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.001	0.894	1.121	0.969	0.850	1.104
SEIFA quartile 3	0.874	0.719	1.063	0.888	0.714	1.105
SEIFA quartile 4	0.902	0.724	1.122	0.908	0.715	1.152
Unemployment%	1.002	0.989	1.016	0.996	0.980	1.013
Indigenous%	1.104*	1.028	1.185	1.072	0.993	1.157
Young males%	0.954*	0.915	0.995	0.933*	0.890	0.978
Male/female%	1.012*	1.003	1.022	1.012*	1.002	1.023
Mean age	0.991	0.961	1.021	0.983	0.953	1.015
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
15km+ from CBD	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.998	1.001	1.000	0.998	1.001
Count of off-premise outlets	0.992	0.974	1.010	0.993	0.974	1.012
On-premise sales[#]/outlet	1.083	0.998	1.175	1.130*	1.034	1.236
Off-premise sales[#]/outlet	1.020*	1.005	1.034	1.020*	1.004	1.036
SEIFA quartile 1[^]	1.000			1.000		
SEIFA quartile 2	1.006	0.930	1.088	1.059	0.970	1.155
SEIFA quartile 3	0.968	0.859	1.090	0.990	0.872	1.125
SEIFA quartile 4	1.077	0.901	1.288	1.047	0.870	1.261
Unemployment%	0.987*	0.976	0.998	0.982*	0.971	0.994
Indigenous%	1.020*	1.013	1.028	1.018*	1.010	1.026
Young males%	1.074*	1.028	1.123	1.068*	1.018	1.122
Male/female%	0.990*	0.982	0.998	0.990*	0.982	0.998
Mean age	1.043	0.992	1.098	1.033	0.981	1.089
ERP 15+	(exposure)			(exposure)		

[#]Sales in 10,000l [*] p<0.05 [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.47: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, stratified by distance from the CBD, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
CBD to 7km	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	1.000	1.001	1.000	0.999	1.001	1.001	1.000	1.002
Count of off-premise outlets	1.023*	1.005	1.042	1.015	0.996	1.034	1.016	0.997	1.036	1.007	0.984	1.029
On-premise sales#/outlet	1.225*	1.050	1.429	1.163	0.999	1.354	1.285*	1.073	1.537	1.237*	1.027	1.490
Off-premise sales#/outlet	0.995	0.964	1.027	0.982	0.951	1.014	0.993	0.956	1.031	0.983	0.944	1.024
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.461	0.996	2.143	1.299	0.871	1.938	1.813*	1.128	2.913	1.505	0.906	2.501
SEIFA quartile 3	1.423	0.941	2.151	1.459	0.927	2.296	1.747*	1.045	2.921	1.863*	1.035	3.354
SEIFA quartile 4	1.501	0.961	2.346	1.578	0.971	2.564	1.920*	1.104	3.340	2.151*	1.147	4.033
Unemployment%	1.000	0.952	1.050	0.961	0.913	1.013	0.986	0.931	1.044	0.946	0.886	1.010
Indigenous%	1.204*	1.095	1.323	1.282*	1.164	1.411	1.225*	1.097	1.368	1.336*	1.185	1.507
Young males%	0.984	0.944	1.026	0.993	0.948	1.041	0.961	0.914	1.011	0.947	0.895	1.004
Male/female%	1.003*	1.001	1.005	1.007*	1.004	1.010	1.002	0.999	1.005	1.006*	1.002	1.010
Mean age	1.020	0.974	1.069	1.028	0.979	1.079	0.992	0.944	1.042	0.997	0.942	1.054
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
7km to 15km from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.995	1.003	1.002	0.998	1.006	1.001	0.996	1.005	1.003	0.999	1.007
Count of off-premise outlets	1.004	0.979	1.029	0.990	0.966	1.015	0.994	0.967	1.021	0.982	0.957	1.007
On-premise sales#/outlet	0.984	0.938	1.033	0.987	0.941	1.035	0.962	0.906	1.022	0.969	0.914	1.027
Off-premise sales#/outlet	1.003	0.996	1.011	1.000	0.992	1.008	1.002	0.993	1.012	0.999	0.989	1.009
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.580*	1.056	2.364	1.314	0.785	2.201	1.564	0.988	2.476	1.080	0.647	1.801
SEIFA quartile 3	1.736*	1.177	2.559	1.413	0.867	2.303	1.572*	1.017	2.431	1.074	0.662	1.743
SEIFA quartile 4	1.645*	1.061	2.552	1.361	0.778	2.381	1.461	0.882	2.419	1.003	0.563	1.788
Unemployment%	1.066	0.991	1.146	1.064	0.969	1.170	1.059	0.973	1.152	1.064	0.963	1.176
Indigenous%	1.229*	1.118	1.350	1.204*	1.071	1.354	1.179*	1.061	1.310	1.108	0.977	1.256
Young males%	0.997	0.927	1.073	0.951	0.876	1.031	1.010	0.931	1.096	0.961	0.883	1.045
Male/female%	0.996	0.993	0.999	0.998	0.994	1.002	0.997	0.994	1.001	1.000	0.995	1.005
Mean age	1.005	0.954	1.058	0.970	0.915	1.029	1.008	0.952	1.067	0.981	0.925	1.040
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
15km+ from CBD	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	0.998	1.010	1.000	0.996	1.004	1.003	0.997	1.009	0.999	0.994	1.003
Count of off-premise outlets	0.983	0.927	1.041	1.013	0.973	1.054	0.991	0.936	1.049	1.023	0.979	1.068
On-premise sales#/outlet	0.990	0.931	1.052	1.039	0.989	1.092	1.004	0.945	1.066	1.040	0.984	1.098
Off-premise sales#/outlet	1.015*	1.003	1.027	1.004	0.996	1.013	1.012	1.000	1.024	1.001	0.992	1.010
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	0.924	0.697	1.225	1.209	0.979	1.494	0.939	0.708	1.245	1.212	0.956	1.536
SEIFA quartile 3	1.156	0.835	1.600	1.208	0.926	1.576	1.140	0.821	1.584	1.219	0.901	1.648
SEIFA quartile 4	0.602*	0.365	0.992	0.848	0.576	1.248	0.612	0.372	1.008	0.879	0.567	1.363
Unemployment%	1.045	0.972	1.124	1.063	1.000	1.129	1.063	0.989	1.144	1.094*	1.021	1.171
Indigenous%	1.093*	1.003	1.191	1.112*	1.036	1.193	1.071	0.984	1.165	1.083*	1.001	1.173
Young males%	1.141*	1.019	1.278	1.070	0.983	1.164	1.162*	1.037	1.301	1.089	0.995	1.193
Male/female%	0.996	0.992	1.001	1.002	0.998	1.007	0.996	0.991	1.001	1.003	0.998	1.008
Mean age	1.065*	1.029	1.102	1.013	0.982	1.044	1.050*	1.014	1.087	1.007	0.973	1.041
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

10.10.3 Models controlling for distance from the CBD

Table 10.48: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status and distance from the CBD, at postcode-level, in the Perth Metropolitan Area between 2004/05 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.006*	1.003	1.010	1.008*	1.004	1.012
Count of off-premise outlets	0.999	0.943	1.059	1.000	0.940	1.064
On-premise sales#/outlet	0.997	0.981	1.013	0.992	0.973	1.011
Off-premise sales#/outlet	0.999	0.989	1.010	1.000	0.988	1.013
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.856*	0.744	0.985	0.843*	0.732	0.970
CBD to 7km	0.838*	0.725	0.968	0.786*	0.681	0.909
CBD	0.233*	0.119	0.455	0.164*	0.082	0.328
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.031	0.964	1.103	1.072	0.989	1.162
SEIFA quartile 3	0.942	0.819	1.083	1.003	0.858	1.173
SEIFA quartile 4	0.966	0.824	1.132	0.997	0.835	1.191
Unemployment%	1.006	0.990	1.022	0.994	0.975	1.013
Indigenous%	1.148*	1.069	1.233	1.166*	1.079	1.259
Young males%	0.985	0.959	1.013	0.978	0.951	1.007
Male/female%	1.015*	1.007	1.023	1.012*	1.003	1.020
Mean age	1.038*	1.002	1.075	1.031	0.994	1.069
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.49: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status and distance from the CBD, at suburb-level, in the Perth Metropolitan Area between 2002/03 and 2009/10

Suburb	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.013*	1.007	1.018	1.012*	1.007	1.018	1.013*	1.007	1.019	1.012*	1.006	1.017
Count of off-premise outlets	0.923*	0.860	0.991	0.933*	0.871	0.999	0.940	0.871	1.014	0.964	0.897	1.037
On-premise sales#/outlet	0.999	0.976	1.022	0.997	0.976	1.019	0.991	0.964	1.018	0.991	0.966	1.016
Off-premise sales#/outlet	1.010*	1.001	1.019	1.004	0.995	1.012	1.004	0.994	1.014	1.000	0.990	1.010
15km+ from CBD^	1.000			1.000			1.000			1.000		
7km to 15km from CBD	0.904	0.757	1.079	0.828*	0.707	0.971	0.822*	0.689	0.981	0.811*	0.690	0.954
CBD to 7km	1.009	0.809	1.258	0.829	0.682	1.007	0.829	0.668	1.029	0.746*	0.611	0.911
CBD	0.591*	0.282	1.239	0.479*	0.240	0.956	0.421*	0.197	0.899	0.400*	0.195	0.820
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.222	0.757	1.079	1.183	0.997	1.402	1.291*	1.061	1.571	1.203	0.986	1.469
SEIFA quartile 3	1.311	0.809	1.258	1.193	0.980	1.453	1.360*	1.092	1.694	1.175	0.932	1.480
SEIFA quartile 4	1.262	0.282	1.239	1.128	0.899	1.415	1.322*	1.026	1.705	1.137	0.869	1.489
Unemployment%	1.083*	1.041	1.126	1.062*	1.018	1.108	1.089*	1.043	1.137	1.060*	1.011	1.111
Indigenous%	1.121*	1.071	1.174	1.123*	1.070	1.180	1.105*	1.050	1.163	1.107*	1.047	1.171
Young males%	0.996	0.960	1.034	0.961*	0.926	0.997	0.991	0.953	1.031	0.955*	0.918	0.994
Male/female%	0.999	0.997	1.000	1.001	0.999	1.004	0.999	0.997	1.001	1.002	0.999	1.004
Mean age	1.042*	1.017	1.068	0.990	0.966	1.015	1.030*	1.003	1.057	0.986	0.961	1.012
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.50: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status and distance from the CBD, at postcode-level, in the Perth Metropolitan Area between 2004/05 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.003	1.011	1.009*	1.005	1.013
Count of off-premise outlets	0.999	0.974	1.023	0.990	0.966	1.016
On-premise sales#/outlet	1.010	0.990	1.030	1.011	0.988	1.033
Off-premise sales#/outlet	1.004	0.995	1.013	1.001	0.991	1.012
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.755*	0.665	0.858	0.759*	0.673	0.856
CBD to 7km	0.810*	0.695	0.945	0.770*	0.666	0.889
CBD	0.242*	0.118	0.495	0.161	0.079	0.327
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.022	0.958	1.091	1.042	0.967	1.123
SEIFA quartile 3	0.994	0.890	1.109	1.028	0.910	1.160
SEIFA quartile 4	1.051	0.919	1.201	1.052	0.910	1.216
Unemployment%	1.003	0.995	1.010	0.998	0.989	1.007
Indigenous%	1.181*	1.116	1.249	1.165*	1.099	1.235
Young males%	0.993	0.966	1.021	0.981	0.954	1.009
Male/female%	1.009*	1.002	1.016	1.007	1.000	1.015
Mean age	1.019	0.990	1.049	1.004	0.976	1.032
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.51: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic and socio-economic status and distance from the CBD, at suburb-level, in the Perth Metropolitan Area between 2002/03 and 2009/10

Suburb	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.998	1.003	1.002	0.999	1.004	1.001	0.998	1.004	1.002	1.000	1.005
Count of off-premise outlets	1.028	0.988	1.069	1.013	0.976	1.052	1.029	0.986	1.073	1.017	0.976	1.060
On-premise sales#/outlet	0.999	0.983	1.015	0.999	0.984	1.014	0.994	0.975	1.013	0.994	0.976	1.012
Off-premise sales#/outlet	1.005	0.999	1.011	1.002	0.996	1.008	1.005	0.998	1.012	1.002	0.995	1.009
15km+ from CBD^	1.000			1.000			1.000			1.000		
7km to 15km from CBD	0.932	0.759	1.143	0.845	0.704	1.016	0.854	0.697	1.046	0.823*	0.682	0.994
CBD to 7km	1.047	0.818	1.341	0.863	0.694	1.073	0.871	0.686	1.105	0.777*	0.620	0.973
CBD	0.891	0.403	1.972	0.661	0.318	1.372	0.598	0.268	1.332	0.479	0.224	1.025
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.234*	1.021	1.491	1.215*	1.010	1.461	1.298*	1.051	1.604	1.228	0.989	1.524
SEIFA quartile 3	1.438*	1.160	1.782	1.246*	1.002	1.550	1.434*	1.130	1.819	1.190	0.924	1.531
SEIFA quartile 4	1.458*	1.131	1.879	1.267	0.977	1.643	1.450*	1.091	1.928	1.222	0.901	1.656
Unemployment%	1.080*	1.034	1.128	1.055*	1.006	1.106	1.073*	1.023	1.126	1.050	0.996	1.107
Indigenous%	1.157*	1.095	1.222	1.165*	1.098	1.236	1.148*	1.081	1.219	1.147*	1.073	1.226
Young males%	0.979	0.941	1.018	0.959	0.919	1.000	0.981	0.940	1.024	0.959	0.916	1.005
Male/female%	0.998	0.997	1.000	1.001	0.999	1.004	0.999	0.997	1.001	1.002	0.999	1.005
Mean age	1.024	0.995	1.053	0.985	0.956	1.016	1.013	0.983	1.044	0.984	0.952	1.016
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.52 Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status and distance from the CBD, at postcode-level, in the Perth Metropolitan Area between 2004/05 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	0.999	0.988	1.010	1.001	0.989	1.012
On-premise sales#/outlet	1.014	0.950	1.083	1.042	0.968	1.122
Off-premise sales#/outlet	1.019*	1.006	1.031	1.016*	1.001	1.031
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.825*	0.695	0.980	0.834*	0.710	0.979
CBD to 7km	1.087	0.833	1.419	1.023	0.793	1.319
CBD	1.672	0.808	3.462	1.326	0.665	2.643
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.978	0.917	1.042	0.994	0.923	1.070
SEIFA quartile 3	0.917	0.831	1.011	0.913	0.821	1.017
SEIFA quartile 4	0.981	0.865	1.112	0.946	0.826	1.084
Unemployment%	0.993	0.985	1.000	0.988*	0.979	0.996
Indigenous%	1.021*	1.015	1.028	1.019*	1.011	1.027
Young males%	1.034*	1.003	1.066	1.022	0.988	1.057
Male/female%	0.999	0.993	1.005	1.000	0.994	1.006
Mean age	1.015	0.981	1.051	1.000	0.965	1.035
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.53: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic and socio-economic status and distance from the CBD, at suburb-level, in the Perth Metropolitan Area between 2002/03 and 2009/10

Suburb	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.002	1.001	1.000	1.002	1.001	1.000	1.002	1.001	1.000	1.002
Count of off-premise outlets	1.006	0.991	1.022	0.997	0.983	1.012	0.998	0.982	1.015	0.991	0.975	1.007
On-premise sales#/outlet	0.989	0.954	1.026	1.008	0.973	1.043	0.983	0.943	1.024	0.993	0.953	1.035
Off-premise sales#/outlet	1.007*	1.001	1.013	1.002	0.996	1.008	1.005	0.998	1.012	1.001	0.994	1.008
15km+ from CBD^	1.000			1.000			1.000			1.000		
7km to 15km from CBD	0.906	0.718	1.144	0.867	0.698	1.078	0.872	0.688	1.105	0.877	0.699	1.099
CBD to 7km	0.922	0.680	1.250	0.843	0.631	1.125	0.816	0.600	1.109	0.792	0.585	1.072
CBD	0.850	0.402	1.798	0.814	0.398	1.664	0.694	0.326	1.478	0.690	0.329	1.444
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.214*	1.004	1.468	1.218*	1.008	1.472	1.262*	1.020	1.561	1.205	0.966	1.504
SEIFA quartile 3	1.389*	1.120	1.721	1.243	0.997	1.550	1.387*	1.093	1.758	1.172	0.909	1.511
SEIFA quartile 4	1.414*	1.096	1.825	1.287	0.988	1.676	1.418*	1.066	1.886	1.235	0.908	1.680
Unemployment%	1.075*	1.030	1.123	1.057*	1.007	1.109	1.073*	1.022	1.126	1.056*	1.001	1.115
Indigenous%	1.159*	1.096	1.224	1.164*	1.095	1.236	1.145*	1.077	1.217	1.140*	1.064	1.222
Young males%	0.983	0.944	1.024	0.961	0.920	1.004	0.986	0.943	1.031	0.961	0.915	1.008
Male/female%	0.999	0.997	1.000	1.001	0.999	1.004	0.999	0.997	1.001	1.002	0.999	1.005
Mean age	1.028	0.999	1.057	0.989	0.958	1.020	1.018	0.987	1.050	0.988	0.955	1.021
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

10.10.4 Model stratifying by area from median distance between traffic signal

Table 10.54: Panel model results for sales and counts of on- and off-premise outlets, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.005*	1.007	1.015	1.013*	1.007	1.018
Count of off-premise outlets	0.996*	0.789	0.935	0.903	0.808	1.009
On-premise sales#/outlet	1.021	0.945	1.091	1.002	0.913	1.100
Off-premise sales#/outlet	1.000	0.967	1.048	1.013	0.962	1.067
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.995	0.599	2.444	1.265	0.526	3.043
SEIFA quartile 3	1.010	0.495	1.331	0.777	0.419	1.442
SEIFA quartile 4	1.020	0.424	1.258	0.611	0.307	1.215
Unemployment%	1.003	0.918	0.995	0.940*	0.890	0.990
Indigenous%	1.138	0.864	1.517	1.028	0.716	1.474
Young males%	0.981	1.107	1.368	1.204*	1.044	1.389
Male/female%	1.013	0.960	1.066	0.979	0.955	1.004
Mean age	1.007	0.911	1.302	1.092	0.871	1.368
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.005*	1.001	1.010	1.006*	1.002	1.011
Count of off-premise outlets	0.996	0.974	1.018	0.991	0.969	1.013
On-premise sales#/outlet	1.021	0.986	1.057	1.012	0.973	1.052
Off-premise sales#/outlet	1.000	0.987	1.014	0.999	0.983	1.015
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.995	0.920	1.075	1.002	0.917	1.095
SEIFA quartile 3	1.010	0.894	1.141	1.018	0.891	1.162
SEIFA quartile 4	1.020	0.871	1.194	1.008	0.849	1.196
Unemployment%	1.003	0.997	1.009	1.001	0.994	1.008
Indigenous%	1.138*	1.074	1.207	1.116*	1.050	1.187
Young males%	0.981	0.953	1.009	0.974	0.947	1.002
Male/female%	1.013*	1.002	1.025	1.015*	1.004	1.027
Mean age	1.007	0.976	1.039	0.987	0.958	1.018
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.056*	1.023	1.090	1.049*	1.010	1.090
Count of off-premise outlets	0.998	0.934	1.068	1.029	0.951	1.113
On-premise sales#/outlet	1.000	0.887	1.127	1.006	0.870	1.162
Off-premise sales#/outlet	1.010	0.993	1.026	1.004	0.984	1.025
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.921	0.819	1.036	0.958	0.833	1.101
SEIFA quartile 3	0.806*	0.680	0.956	0.829	0.678	1.015
SEIFA quartile 4	1.249	0.942	1.656	1.197	0.863	1.660
Unemployment%	0.989	0.965	1.014	0.982	0.953	1.011
Indigenous%	1.081	0.968	1.208	1.056	0.935	1.193
Young males%	0.959	0.911	1.010	0.948	0.891	1.008
Male/female%	0.994	0.983	1.005	0.998	0.986	1.010
Mean age	0.962	0.903	1.025	0.955	0.890	1.025
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.55: Panel model results for sales and counts of on- and off-premise outlets, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Median distance of up to 300m between traffic signals	2004/05 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.002	0.999	1.006	1.002	0.998	1.005
Count of off-premise outlets	0.972	0.896	1.055	1.031	0.951	1.118
On-premise sales#/outlet	0.961	0.837	1.103	0.975	0.837	1.135
Off-premise sales#/outlet	0.960	0.913	1.009	0.968	0.920	1.020
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.034	0.671	1.594	0.882	0.577	1.349
SEIFA quartile 3	0.946	0.628	1.426	0.808	0.541	1.207
SEIFA quartile 4	0.984	0.594	1.630	0.724	0.443	1.183
Unemployment%	0.994	0.906	1.091	0.922	0.846	1.005
Indigenous%	1.120*	1.008	1.243	1.086	0.981	1.203
Young males%	1.025	0.953	1.102	1.036	0.965	1.112
Male/female%	1.005*	1.002	1.008	1.004	1.000	1.008
Mean age	0.947*	0.900	0.997	0.926*	0.880	0.974
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 300m to 1,000m between traffic signals	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	0.994	1.013	1.014*	1.006	1.021	1.009	0.999	1.019	1.015*	1.007	1.023
Count of off-premise outlets	0.981	0.925	1.041	0.959	0.915	1.006	0.977	0.922	1.035	0.964	0.916	1.013
On-premise sales#/outlet	1.001	0.966	1.038	1.003	0.972	1.034	1.002	0.964	1.041	1.003	0.969	1.039
Off-premise sales#/outlet	1.027*	1.008	1.046	1.022*	1.006	1.038	1.024*	1.003	1.046	1.022*	1.003	1.040
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.098	0.942	1.280	1.044	0.901	1.209	1.206*	1.024	1.420	1.112	0.940	1.315
SEIFA quartile 3	0.983	0.801	1.205	0.893	0.736	1.083	1.061	0.859	1.309	0.942	0.760	1.169
SEIFA quartile 4	0.981	0.781	1.232	0.838	0.670	1.049	1.054	0.830	1.339	0.895	0.694	1.154
Unemployment%	1.124*	1.074	1.177	1.073*	1.023	1.125	1.116*	1.062	1.173	1.065*	1.009	1.124
Indigenous%	1.090*	1.044	1.139	1.084*	1.037	1.133	1.087*	1.038	1.138	1.081*	1.029	1.136
Young males%	0.981	0.940	1.023	0.966	0.930	1.003	0.982	0.941	1.024	0.969	0.930	1.010
Male/female%	1.000	0.998	1.003	1.000	0.997	1.004	1.001	0.998	1.004	1.002	0.998	1.005
Mean age	1.047*	1.018	1.076	1.006	0.983	1.030	1.032*	1.004	1.060	1.001	0.976	1.026
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 1,500m or	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
more between traffic signals	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.075*	1.034	1.117	1.027	0.994	1.060	1.070*	1.028	1.114	1.023	0.988	1.060
Count of off-premise outlets	1.069	0.930	1.229	1.057	0.950	1.177	1.100	0.951	1.271	1.114	0.985	1.260
On-premise sales#/outlet	1.019	0.953	1.090	0.982	0.935	1.031	1.002	0.933	1.076	0.975	0.917	1.036
Off-premise sales#/outlet	1.010	0.973	1.049	0.988	0.960	1.017	1.007	0.968	1.047	0.991	0.957	1.026
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.127	0.826	1.536	0.941	0.753	1.176	1.152	0.827	1.605	1.016	0.759	1.360
SEIFA quartile 3	1.159	0.806	1.665	0.905	0.693	1.182	1.199	0.819	1.755	0.986	0.699	1.392
SEIFA quartile 4	0.843	0.524	1.354	0.721	0.510	1.019	0.953	0.585	1.553	0.853	0.554	1.313
Unemployment%	1.110*	1.038	1.188	1.124*	1.055	1.197	1.118*	1.041	1.201	1.133*	1.057	1.216
Indigenous%	0.962	0.861	1.076	0.971	0.884	1.067	0.983	0.875	1.106	0.971	0.867	1.086
Young males%	1.023	0.952	1.099	0.965	0.907	1.028	1.014	0.940	1.093	0.937	0.873	1.005
Male/female%	0.996*	0.992	0.999	1.000	0.996	1.003	0.996	0.992	1.000	1.001	0.997	1.005
Mean age	1.044*	1.001	1.088	0.985	0.956	1.015	1.023	0.984	1.065	0.976	0.945	1.008
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.56: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.011*	1.006	1.016	1.013*	1.007	1.019
Count of off-premise outlets	0.859*	0.773	0.953	0.879	0.764	1.012
On-premise sales#/outlet	1.015	0.968	1.064	1.003	0.944	1.065
Off-premise sales#/outlet	1.007	0.956	1.062	1.029	0.961	1.103
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.000			1.000		
SEIFA quartile 3	0.599	0.314	1.143	0.595	0.282	1.253
SEIFA quartile 4	0.522	0.262	1.038	0.439*	0.197	0.977
Unemployment%	0.991	0.965	1.018	0.987	0.953	1.022
Indigenous%	1.062	0.767	1.471	0.905	0.598	1.370
Young males%	1.282*	1.120	1.468	1.258*	1.068	1.483
Male/female%	0.969*	0.947	0.991	0.968*	0.942	0.993
Mean age	1.000	0.825	1.212	1.039	0.825	1.309
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.993	0.980	1.006	0.993	0.980	1.007
Count of off-premise outlets	1.048	0.973	1.128	1.016	0.939	1.099
On-premise sales#/outlet	0.995	0.978	1.012	0.989	0.970	1.009
Off-premise sales#/outlet	0.995	0.982	1.008	0.996	0.981	1.011
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.081	0.995	1.174	1.106*	1.002	1.221
SEIFA quartile 3	0.986	0.839	1.160	1.031	0.858	1.238
SEIFA quartile 4	1.037	0.867	1.241	1.068	0.872	1.308
Unemployment%	1.011	0.999	1.023	1.005	0.991	1.020
Indigenous%	1.148*	1.057	1.248	1.153*	1.054	1.262
Young males%	0.979	0.951	1.009	0.976	0.946	1.007
Male/female%	1.026*	1.014	1.038	1.028*	1.015	1.040
Mean age	1.042	0.995	1.091	1.037	0.988	1.088
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.57: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
Median distance of up to 300m between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.004	1.000	1.009	1.005	1.000	1.009	1.004	0.999	1.009	1.005	0.999	1.010
Count of off-premise outlets	1.020	0.950	1.096	1.019	0.950	1.093	1.034	0.960	1.112	1.042	0.965	1.125
On-premise sales#/outlet	1.022	0.991	1.053	1.013	0.983	1.043	1.017	0.979	1.055	1.007	0.970	1.045
Off-premise sales#/outlet	0.985	0.958	1.012	0.982	0.956	1.008	0.988	0.959	1.019	0.986	0.956	1.017
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.438	0.989	2.092	1.211	0.653	2.246	1.280	0.828	1.978	1.009	0.500	2.039
SEIFA quartile 3	1.307	0.898	1.903	1.178	0.633	2.192	1.197	0.772	1.856	1.044	0.506	2.156
SEIFA quartile 4	1.377	0.853	2.222	1.127	0.530	2.396	1.142	0.656	1.989	0.883	0.368	2.121
Unemployment%	1.043	0.967	1.124	0.962	0.893	1.036	0.999	0.926	1.078	0.919	0.843	1.002
Indigenous%	1.150*	1.044	1.266	1.173*	1.023	1.346	1.121*	1.007	1.249	1.135	0.968	1.331
Young males%	0.967	0.917	1.019	0.981	0.925	1.041	0.965	0.912	1.022	0.987	0.923	1.054
Male/female%	1.001	0.999	1.003	1.004*	1.001	1.006	1.001	0.998	1.003	1.003	0.999	1.006
Mean age	0.944*	0.909	0.979	0.940*	0.906	0.976	0.925*	0.889	0.963	0.918*	0.880	0.959
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 300m to 1,000m between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.032*	1.006	1.059	1.043*	1.017	1.069	1.035*	1.008	1.063	1.035*	1.008	1.064
Count of off-premise outlets	0.815*	0.729	0.912	0.817*	0.726	0.919	0.829*	0.733	0.938	0.855	0.752	0.971
On-premise sales#/outlet	0.999	0.970	1.030	0.996	0.967	1.026	0.991	0.956	1.026	0.987	0.953	1.023
Off-premise sales#/outlet	1.007	0.995	1.020	1.005	0.993	1.017	0.999	0.985	1.013	1.000	0.986	1.013
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.149	0.906	1.456	1.200	0.943	1.527	1.275	0.980	1.660	1.268	0.967	1.663
SEIFA quartile 3	1.264	0.951	1.679	1.174	0.863	1.598	1.269	0.920	1.752	1.147	0.804	1.635
SEIFA quartile 4	1.231	0.895	1.695	1.160	0.818	1.644	1.247	0.865	1.800	1.175	0.779	1.774
Unemployment%	1.097*	1.034	1.163	1.090*	1.012	1.173	1.100*	1.029	1.176	1.106*	1.016	1.203
Indigenous%	1.182*	1.109	1.260	1.160*	1.072	1.256	1.166*	1.083	1.256	1.133*	1.035	1.241
Young males%	0.994	0.939	1.053	0.962	0.901	1.028	1.003	0.943	1.067	0.958	0.893	1.028
Male/female%	0.999	0.996	1.002	1.002	0.998	1.006	1.000	0.997	1.003	1.004	0.999	1.008
Mean age	1.040	0.999	1.083	0.977	0.929	1.027	1.041	0.995	1.088	0.985	0.934	1.039
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 1,500m or more between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.988	0.891	1.096	1.002	0.936	1.073	0.989	0.896	1.092	1.017	0.940	1.100
Count of off-premise outlets	0.904	0.578	1.413	1.088	0.844	1.402	1.015	0.695	1.484	1.085	0.805	1.461
On-premise sales[#]/outlet	0.999	0.890	1.122	0.992	0.923	1.066	0.996	0.886	1.118	0.980	0.897	1.071
Off-premise sales[#]/outlet	1.023*	1.002	1.045	1.010	0.998	1.022	1.019	0.998	1.040	1.005	0.990	1.020
SEIFA quartile 1[^]	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.318	0.859	2.021	1.188	0.901	1.565	1.373	0.875	2.154	1.330	0.943	1.875
SEIFA quartile 3	1.386	0.849	2.264	1.207	0.885	1.646	1.402	0.849	2.315	1.283	0.874	1.883
SEIFA quartile 4	1.065	0.599	1.891	1.022	0.703	1.487	1.198	0.672	2.133	1.189	0.756	1.871
Unemployment%	1.062	0.957	1.178	1.015	0.943	1.092	1.049	0.943	1.166	0.999	0.911	1.095
Indigenous%	1.080	0.911	1.280	1.167*	1.048	1.301	1.112	0.947	1.307	1.208*	1.057	1.380
Young males%	1.049	0.956	1.151	0.985	0.914	1.061	1.038	0.944	1.141	0.977	0.896	1.066
Male/female%	0.996	0.991	1.001	0.998	0.994	1.003	0.995	0.989	1.000	0.998	0.992	1.003
Mean age	1.106*	1.025	1.193	1.004	0.968	1.042	1.069*	1.007	1.134	0.997	0.956	1.040
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

[#]Sales in 10,000l [*] p<0.05 [^]Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.58: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.008*	1.003	1.013	Not converge		
Count of off-premise outlets	0.959	0.907	1.015			
On-premise sales#/outlet	0.970	0.904	1.041			
Off-premise sales#/outlet	1.017	0.962	1.074			
SEIFA quartile 1^	1.000					
SEIFA quartile 2	0.891	0.335	2.365			
SEIFA quartile 3	0.628	0.312	1.263			
SEIFA quartile 4	0.555	0.261	1.177			
Unemployment%	0.980	0.955	1.007			
Indigenous%	1.029	0.742	1.427			
Young males%	1.246*	1.082	1.436			
Male/female%	0.982	0.959	1.006			
Mean age	1.095	0.890	1.347			
ERP 15+	(exposure)					

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.985	1.012	1.003	0.988	1.018
Count of off-premise outlets	1.011	0.975	1.048	0.997	0.960	1.037
On-premise sales#/outlet	1.012	0.988	1.037	1.015	0.988	1.043
Off-premise sales#/outlet	1.000	0.988	1.012	0.997	0.984	1.011
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.034	0.958	1.117	1.048	0.958	1.147
SEIFA quartile 3	0.971	0.843	1.118	1.018	0.868	1.195
SEIFA quartile 4	1.018	0.861	1.203	1.052	0.870	1.271
Unemployment%	1.003	0.994	1.012	1.001	0.991	1.012
Indigenous%	1.144*	1.062	1.232	1.137*	1.052	1.230
Young males%	0.982	0.951	1.014	0.974	0.942	1.007
Male/female%	1.012*	1.003	1.021	1.014*	1.005	1.023
Mean age	1.011	0.969	1.053	0.992	0.951	1.034
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.081	0.942	1.239	1.061	0.910	1.237
Count of off-premise outlets	0.956	0.730	1.253	0.957	0.709	1.292
On-premise sales#/outlet	1.037	0.968	1.112	1.035	0.956	1.121
Off-premise sales#/outlet	1.006	0.991	1.022	1.003	0.984	1.022
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.950	0.805	1.120	1.016	0.843	1.223
SEIFA quartile 3	0.908	0.678	1.215	0.978	0.702	1.362
SEIFA quartile 4	1.537*	1.032	2.290	1.668*	1.077	2.584
Unemployment%	0.989	0.950	1.029	0.997	0.952	1.044
Indigenous%	1.174*	1.024	1.347	1.170*	1.016	1.347
Young males%	0.912	0.776	1.071	0.958	0.799	1.148
Male/female%	0.971	0.906	1.042	0.954	0.880	1.035
Mean age	1.010	0.909	1.123	1.016	0.902	1.145
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.59: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
Median distance of up to 300m between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.998	1.002	1.001	0.999	1.003	1.000	0.998	1.002	1.001	0.999	1.003
Count of off-premise outlets	1.015	0.978	1.054	1.009	0.970	1.048	1.024	0.985	1.063	1.015	0.972	1.060
On-premise sales#/outlet	1.018	0.983	1.055	1.011	0.977	1.046	1.013	0.968	1.061	1.000	0.957	1.046
Off-premise sales#/outlet	0.994	0.967	1.022	1.000	0.974	1.028	1.001	0.971	1.032	1.008	0.976	1.040
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.440	0.968	2.143	1.350	0.645	2.829	1.322	0.824	2.120	1.148	0.491	2.683
SEIFA quartile 3	1.321	0.891	1.960	1.326	0.643	2.734	1.242	0.780	1.978	1.161	0.499	2.704
SEIFA quartile 4	1.623	0.989	2.664	1.501	0.638	3.532	1.351	0.764	2.391	1.132	0.420	3.052
Unemployment%	1.096	0.999	1.203	1.000	0.907	1.103	1.043	0.950	1.144	0.941	0.846	1.047
Indigenous%	1.162*	1.049	1.288	1.218*	1.042	1.423	1.139*	1.015	1.279	1.179	0.981	1.417
Young males%	0.958	0.896	1.025	0.980	0.907	1.058	0.966	0.897	1.039	0.990	0.907	1.081
Male/female%	1.002	1.000	1.004	1.004*	1.001	1.007	1.001	0.999	1.004	1.003	0.999	1.007
Mean age	0.944*	0.905	0.986	0.943*	0.900	0.987	0.933*	0.890	0.978	0.924*	0.878	0.973
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 300m to 1,000m between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.989*	0.979	0.999	0.998	0.988	1.007	0.994	0.984	1.005	1.001	0.992	1.011
Count of off-premise outlets	1.039	0.947	1.140	0.991	0.904	1.085	1.023	0.922	1.134	0.997	0.903	1.100
On-premise sales[#]/outlet	0.993	0.973	1.013	0.993	0.973	1.013	0.990	0.966	1.014	0.991	0.968	1.016
Off-premise sales[#]/outlet	1.003	0.988	1.019	0.997	0.980	1.014	0.999	0.980	1.018	0.997	0.977	1.016
SEIFA quartile 1[^]	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.127	0.881	1.441	1.203	0.936	1.547	1.280	0.966	1.696	1.266	0.950	1.686
SEIFA quartile 3	1.525*	1.127	2.064	1.310	0.946	1.814	1.528*	1.085	2.152	1.202	0.828	1.746
SEIFA quartile 4	1.456*	1.033	2.053	1.276	0.879	1.852	1.485*	1.003	2.201	1.245	0.804	1.928
Unemployment%	1.112*	1.041	1.189	1.094*	1.005	1.190	1.111*	1.029	1.200	1.116*	1.015	1.227
Indigenous%	1.218*	1.112	1.333	1.166*	1.053	1.291	1.185*	1.073	1.310	1.117*	1.001	1.246
Young males%	0.974	0.911	1.041	0.955	0.886	1.029	0.984	0.915	1.058	0.945	0.874	1.021
Male/female%	0.998	0.995	1.001	1.000	0.996	1.005	0.999	0.996	1.003	1.003	0.998	1.008
Mean age	1.040	0.986	1.098	0.975	0.920	1.033	1.028	0.970	1.089	0.969	0.913	1.029
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

[#]Sales in 10,000l [*] $p<0.05$ [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 1,500m or more between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.970	1.028	0.997	0.975	1.020	1.000	0.971	1.030	1.004	0.977	1.032
Count of off-premise outlets	1.112	0.944	1.310	1.116	0.992	1.254	1.136	0.963	1.342	1.138	0.992	1.306
On-premise sales#/outlet	0.994	0.952	1.039	1.000	0.969	1.031	0.980	0.936	1.027	0.982	0.945	1.021
Off-premise sales#/outlet	1.004	0.995	1.012	1.001	0.995	1.007	1.004	0.994	1.013	1.001	0.993	1.009
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.419	0.842	2.392	1.246	0.885	1.754	1.492	0.882	2.523	1.400	0.939	2.089
SEIFA quartile 3	1.531	0.830	2.823	1.168	0.786	1.736	1.450	0.794	2.650	1.201	0.756	1.907
SEIFA quartile 4	1.261	0.550	2.893	1.126	0.633	2.003	1.193	0.530	2.684	1.190	0.605	2.343
Unemployment%	1.013	0.924	1.112	1.001	0.931	1.075	1.001	0.911	1.099	0.990	0.907	1.081
Indigenous%	1.263*	1.089	1.465	1.252*	1.117	1.402	1.271*	1.093	1.477	1.292*	1.123	1.487
Young males%	0.999	0.910	1.097	0.959	0.888	1.037	0.991	0.901	1.090	0.945	0.860	1.038
Male/female%	0.993*	0.988	0.998	0.996	0.992	1.001	0.992*	0.987	0.997	0.996	0.990	1.002
Mean age	1.053	0.997	1.111	1.001	0.957	1.047	1.052	0.995	1.111	1.004	0.952	1.060
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.60: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Median distance of up to 300m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.997	1.001	0.997	0.994	1.000
Count of off-premise outlets	0.998	0.970	1.027	1.021	0.987	1.057
On-premise sales#/outlet	0.664*	0.445	0.989	0.516*	0.308	0.867
Off-premise sales#/outlet	0.946	0.835	1.072	0.910	0.775	1.069
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.931	0.415	2.092	1.470	0.707	3.058
SEIFA quartile 3	0.720	0.346	1.498	0.934	0.518	1.683
SEIFA quartile 4	0.750	0.351	1.602	0.881	0.478	1.625
Unemployment%	0.959*	0.932	0.986	0.932*	0.900	0.965
Indigenous%	1.008	0.694	1.463	1.238	0.813	1.885
Young males%	1.240*	1.079	1.426	1.183*	1.014	1.381
Male/female%	1.003	0.980	1.025	0.997	0.977	1.019
Mean age	1.042	0.870	1.248	0.929	0.778	1.110
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 300m to 1,000m between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	0.992	0.981	1.004	0.990	0.978	1.001
On-premise sales#/outlet	1.015	0.938	1.098	1.036	0.948	1.131
Off-premise sales#/outlet	1.020	0.999	1.041	1.011	0.988	1.036
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.026	0.951	1.106	1.040	0.953	1.134
SEIFA quartile 3	0.983	0.864	1.118	1.004	0.871	1.157
SEIFA quartile 4	1.009	0.861	1.182	1.016	0.854	1.207
Unemployment%	1.002	0.993	1.011	0.999	0.989	1.009
Indigenous%	1.117*	1.046	1.192	1.104*	1.032	1.180
Young males%	0.989	0.958	1.020	0.983	0.952	1.015
Male/female%	1.012*	1.003	1.021	1.013*	1.003	1.022
Mean age	1.029	0.990	1.070	1.022	0.982	1.064
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Median distance of 1,500m or more between traffic signals	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.015	0.997	1.033	1.013	0.994	1.034
Count of off-premise outlets	0.964	0.925	1.004	0.965	0.923	1.009
On-premise sales#/outlet	1.151*	1.001	1.322	1.241*	1.067	1.444
Off-premise sales#/outlet	1.015	0.999	1.031	1.015	0.996	1.034
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.903	0.794	1.028	0.947	0.816	1.100
SEIFA quartile 3	0.751*	0.630	0.896	0.761*	0.621	0.932
SEIFA quartile 4	1.070	0.829	1.381	1.006	0.765	1.322
Unemployment%	0.955*	0.930	0.981	0.942*	0.913	0.972
Indigenous%	1.021*	1.014	1.027	1.018*	1.011	1.026
Young males%	1.121*	1.022	1.230	1.111	0.998	1.238
Male/female%	0.988*	0.981	0.996	0.989*	0.981	0.997
Mean age	0.921*	0.868	0.977	0.905*	0.853	0.960
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.61: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, stratified by traffic signal zone, adjusting for demographic and socio-economic status, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries		
Median distance of up to 300m between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.999	0.998	1.001	0.999	0.998	1.001	1.000	0.998	1.001
Count of off-premise outlets	1.015	0.996	1.034	1.013	0.991	1.036	1.009	0.988	1.030
On-premise sales#/outlet	1.041	0.993	1.091	1.030	0.984	1.078	1.032	0.971	1.098
Off-premise sales#/outlet	0.997	0.971	1.024	1.004	0.977	1.031	0.998	0.968	1.029
SEIFA quartile 1^	1.000			1.000			1.000		
SEIFA quartile 2	1.475	0.991	2.195	1.405	0.627	3.151	1.359	0.831	2.224
SEIFA quartile 3	1.350	0.911	2.000	1.401	0.646	3.040	1.280	0.797	2.057
SEIFA quartile 4	1.784*	1.108	2.872	1.777	0.750	4.209	1.506	0.841	2.698
Unemployment%	1.108*	1.010	1.214	1.028	0.930	1.136	1.055	0.962	1.156
Indigenous%	1.179*	1.060	1.311	1.239*	1.048	1.465	1.152*	1.017	1.304
Young males%	0.954	0.890	1.022	0.978	0.902	1.061	0.953	0.882	1.030
Male/female%	1.002	1.000	1.004	1.004*	1.001	1.007	1.001	0.998	1.004
Mean age	0.953	0.906	1.002	0.942	0.887	1.002	0.944	0.890	1.001
ERP 15+	(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 300m to 1,000m between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.001	1.000	1.003	1.002	1.000	1.003	1.001	1.000	1.003	1.002	1.000	1.003
Count of off-premise outlets	0.990	0.969	1.012	0.977*	0.956	0.998	0.977	0.955	1.000	0.968*	0.945	0.990
On-premise sales#/outlet	0.981	0.922	1.044	0.978	0.920	1.040	0.970	0.903	1.041	0.965	0.899	1.034
Off-premise sales#/outlet	1.007	0.996	1.018	1.001	0.989	1.012	1.001	0.988	1.013	0.997	0.984	1.010
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.166	0.916	1.485	1.184	0.926	1.516	1.240	0.942	1.634	1.200	0.905	1.593
SEIFA quartile 3	1.543*	1.147	2.077	1.306	0.950	1.796	1.540*	1.098	2.161	1.265	0.881	1.816
SEIFA quartile 4	1.475*	1.042	2.088	1.257	0.861	1.834	1.473	0.986	2.200	1.281	0.826	1.985
Unemployment%	1.098*	1.029	1.171	1.086*	1.001	1.179	1.101*	1.023	1.186	1.120*	1.022	1.228
Indigenous%	1.229*	1.129	1.338	1.163*	1.054	1.283	1.184*	1.076	1.301	1.107	0.994	1.234
Young males%	0.973	0.915	1.034	0.959	0.893	1.029	0.987	0.922	1.057	0.950	0.879	1.025
Male/female%	0.998	0.995	1.001	1.000	0.996	1.005	0.999	0.995	1.002	1.002	0.997	1.007
Mean age	1.014	0.969	1.062	0.974	0.921	1.029	1.016	0.966	1.069	0.975	0.919	1.034
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

	Night2 injuries						Weekend Night2 injuries					
Median distance of 1,500m or more between traffic signals	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	0.996	0.983	1.009	1.000	0.991	1.009	0.996	0.983	1.010	0.999	0.989	1.010
Count of off-premise outlets	1.010	0.953	1.071	0.990	0.952	1.030	1.002	0.945	1.062	0.987	0.942	1.035
On-premise sales#/outlet	0.980	0.905	1.062	1.052	0.983	1.125	0.984	0.907	1.068	1.031	0.946	1.125
Off-premise sales#/outlet	1.006	0.996	1.016	1.003	0.996	1.010	1.007	0.996	1.017	1.003	0.994	1.012
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.400	0.818	2.394	1.388	0.958	2.011	1.467	0.865	2.485	1.472	0.952	2.278
SEIFA quartile 3	1.659	0.906	3.038	1.426	0.946	2.149	1.602	0.890	2.883	1.417	0.875	2.293
SEIFA quartile 4	1.645	0.667	4.058	1.564	0.835	2.928	1.644	0.683	3.958	1.639	0.785	3.426
Unemployment%	1.019	0.922	1.126	0.996	0.930	1.067	1.005	0.910	1.111	0.981	0.903	1.066
Indigenous%	1.243*	1.068	1.448	1.256*	1.125	1.402	1.238*	1.064	1.441	1.275*	1.116	1.457
Young males%	1.012	0.923	1.108	0.972	0.908	1.040	1.012	0.923	1.109	0.974	0.898	1.056
Male/female%	0.994*	0.988	0.999	0.995*	0.990	0.999	0.992*	0.987	0.998	0.994	0.988	1.000
Mean age	1.063*	1.005	1.125	1.004	0.963	1.047	1.061*	1.002	1.123	1.012	0.963	1.065
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

10.10.5 Models controlling for median distance between traffic signals

Table 10.62: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic, socio-economic status and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.007*	1.004	1.009	1.008*	1.005	1.010
Count of off-premise outlets	0.990	0.968	1.011	0.992	0.969	1.015
On-premise sales#/outlet	1.012	0.981	1.044	1.001	0.966	1.038
Off-premise sales#/outlet	1.008	0.998	1.019	1.006	0.994	1.018
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.824	0.624	1.087	0.894	0.680	1.175
300m-1,000m between signals	0.928	0.799	1.078	0.936	0.806	1.087
Up to 300m between signals	1.078	0.881	1.320	1.011	0.825	1.238
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.980	0.918	1.046	0.997	0.925	1.074
SEIFA quartile 3	0.957	0.869	1.055	0.963	0.865	1.073
SEIFA quartile 4	0.982	0.861	1.121	0.961	0.833	1.108
Unemployment%	1.001	0.995	1.007	0.998	0.991	1.005
Indigenous%	1.122*	1.067	1.181	1.110*	1.051	1.171
Young males%	0.990	0.966	1.015	0.979	0.953	1.006
Male/female%	0.996	0.990	1.002	0.997	0.990	1.003
Mean age	0.996	0.969	1.024	0.982	0.955	1.010
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.63: Panel model results for sales and counts of on- and off-premise outlets, adjusting for demographic, socio-economic status and traffic signal zone, at suburb-level in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.002	0.998	1.006	1.003*	1.000	1.007	1.002	0.998	1.006	1.003*	1.000	1.007
Count of off-premise outlets	1.003	0.955	1.054	0.994	0.951	1.038	1.017	0.966	1.070	1.016	0.970	1.065
On-premise sales#/outlet	0.994	0.963	1.025	0.988	0.961	1.015	0.989	0.956	1.024	0.986	0.955	1.018
Off-premise sales#/outlet	1.020*	1.004	1.037	1.012	0.998	1.025	1.019*	1.001	1.037	1.011	0.995	1.027
1,500m+ between traffic signals^	1.000			1.000			1.000			1.000		
1,000m -1,500m between signals	0.904	0.612	1.337	0.928	0.658	1.307	0.842	0.565	1.254	0.849	0.589	1.223
300m-1,000m between signals	0.996	0.863	1.150	0.959	0.845	1.088	0.963	0.834	1.112	0.947	0.830	1.080
Up to 300m between signals	1.144	0.952	1.376	1.068	0.907	1.257	1.078	0.896	1.296	0.990	0.835	1.173
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.083	0.950	1.234	1.021	0.898	1.162	1.147	0.995	1.323	1.071	0.922	1.245
SEIFA quartile 3	1.110	0.944	1.305	0.957	0.818	1.121	1.146	0.964	1.362	0.985	0.821	1.183
SEIFA quartile 4	1.146	0.948	1.385	0.921	0.766	1.107	1.178	0.963	1.442	0.962	0.778	1.189
Unemployment%	1.142*	1.105	1.180	1.098*	1.060	1.137	1.138*	1.099	1.179	1.094*	1.052	1.137
Indigenous%	1.069*	1.029	1.111	1.063*	1.021	1.107	1.061*	1.017	1.106	1.052*	1.005	1.102
Young males%	0.985	0.953	1.018	0.962*	0.931	0.993	0.987	0.954	1.022	0.957*	0.924	0.991
Male/female%	0.998	0.997	1.000	1.001	0.999	1.003	0.999	0.997	1.000	1.001	0.999	1.003
Mean age	1.039*	1.019	1.059	0.992	0.974	1.010	1.026*	1.006	1.047	0.985	0.966	1.004
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.64: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Within 1km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	1.000	1.007	1.004	1.000	1.008
Count of off-premise outlets	0.978	0.916	1.043	0.977	0.908	1.050
On-premise sales#/outlet	0.998	0.982	1.015	0.993	0.974	1.012
Off-premise sales#/outlet	1.002	0.991	1.012	1.001	0.988	1.013
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.852	0.566	1.282	0.887	0.582	1.351
300m-1,000m between signals	0.779	0.602	1.008	0.763	0.583	1.000
Up to 300m between signals	0.821	0.606	1.111	0.778	0.567	1.068
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.050	0.979	1.126	1.080	0.993	1.176
SEIFA quartile 3	0.964	0.832	1.118	1.034	0.873	1.225
SEIFA quartile 4	1.024	0.870	1.205	1.068	0.887	1.285
Unemployment%	1.009	1.000	1.019	1.001	0.990	1.013
Indigenous%	1.138*	1.051	1.233	1.162*	1.064	1.269
Young males%	0.985	0.955	1.016	0.980	0.948	1.014
Male/female%	1.012*	1.002	1.021	1.008	0.998	1.018
Mean age	1.034	0.992	1.078	1.030	0.985	1.078
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.65: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid, adjusting for demographic and socio-economic status, and traffic signal zone, at suburb-level, in Perth Metropolitan Area between 2003/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 1km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.010*	1.004	1.015	1.010*	1.005	1.015	1.009*	1.003	1.015	1.008*	1.003	1.014
Count of off-premise outlets	0.920*	0.855	0.989	0.928*	0.864	0.997	0.938	0.867	1.015	0.964	0.894	1.040
On-premise sales#/outlet	0.998	0.976	1.021	0.995	0.974	1.017	0.988	0.962	1.015	0.987	0.962	1.013
Off-premise sales#/outlet	1.010	1.000	1.019	1.004	0.996	1.013	1.004	0.994	1.015	1.001	0.991	1.011
1,500m+ between traffic signals^	1.000			1.000			1.000			1.000		
1,000m -1,500m between signals	0.878	0.589	1.307	0.832	0.574	1.206	0.732	0.479	1.119	0.710	0.475	1.061
300m-1,000m between signals	0.996	0.820	1.210	0.963	0.803	1.155	0.953	0.780	1.164	0.954	0.790	1.151
Up to 300m between signals	1.221	0.958	1.557	1.050	0.840	1.313	1.087	0.850	1.390	0.964	0.767	1.212
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.215*	1.017	1.452	1.173	0.985	1.395	1.275*	1.044	1.558	1.191	0.971	1.460
SEIFA quartile 3	1.292*	1.060	1.574	1.172	0.960	1.431	1.316*	1.054	1.644	1.144	0.904	1.447
SEIFA quartile 4	1.269*	1.007	1.599	1.123	0.890	1.417	1.310*	1.009	1.700	1.130	0.855	1.493
Unemployment%	1.080*	1.037	1.124	1.055*	1.009	1.103	1.082*	1.034	1.131	1.049	0.998	1.103
Indigenous%	1.123*	1.072	1.176	1.136*	1.080	1.194	1.114*	1.057	1.173	1.126*	1.062	1.193
Young males%	1.002	0.964	1.042	0.967	0.929	1.007	0.999	0.958	1.042	0.961	0.921	1.004
Male/female%	0.998	0.997	1.000	1.001	0.999	1.003	0.999	0.997	1.001	1.001	0.999	1.004
Mean age	1.040*	1.013	1.067	0.984	0.959	1.010	1.026	0.999	1.055	0.980	0.953	1.008
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.66: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic, socio-economic status and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.003	1.000	1.006	1.004*	1.001	1.008
Count of off-premise outlets	0.996	0.970	1.023	0.990	0.962	1.020
On-premise sales#/outlet	1.011	0.991	1.033	1.012	0.989	1.037
Off-premise sales#/outlet	1.005	0.996	1.015	1.002	0.991	1.013
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.730*	0.543	0.979	0.804	0.600	1.078
300m-1,000m between signals	0.857	0.696	1.056	0.881	0.715	1.086
Up to 300m between signals	0.955	0.729	1.253	0.926	0.705	1.215
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	1.015	0.951	1.084	1.037	0.961	1.120
SEIFA quartile 3	0.979	0.874	1.097	1.017	0.895	1.155
SEIFA quartile 4	1.071	0.933	1.229	1.080	0.926	1.260
Unemployment%	0.999	0.992	1.007	0.995	0.986	1.004
Indigenous%	1.164*	1.093	1.241	1.155*	1.079	1.236
Young males%	1.003	0.973	1.034	0.993	0.961	1.025
Male/female%	1.007	0.998	1.015	1.005	0.995	1.014
Mean age	1.008	0.975	1.043	0.992	0.958	1.028
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.67: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, adjusting for demographic, socio-economic status and traffic signal zone, at suburb-level in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 2km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.998	1.002	1.001	0.999	1.003	1.000	0.998	1.003	1.001	0.999	1.003
Count of off-premise outlets	1.016	0.976	1.059	1.006	0.966	1.046	1.020	0.976	1.067	1.013	0.970	1.059
On-premise sales#/outlet	0.999	0.983	1.015	0.999	0.984	1.014	0.994	0.975	1.013	0.993	0.975	1.012
Off-premise sales#/outlet	1.005	0.999	1.011	1.002	0.996	1.007	1.005	0.998	1.012	1.002	0.995	1.009
1,500m+ between traffic signals^	1.000			1.000			1.000			1.000		
1,000m -1,500m between signals	1.008	0.663	1.532	0.883	0.598	1.305	0.901	0.581	1.397	0.831	0.546	1.266
300m-1,000m between signals	1.201	0.957	1.507	1.043	0.845	1.286	1.111	0.881	1.400	1.031	0.826	1.286
Up to 300m between signals	1.388*	1.052	1.830	1.116	0.867	1.436	1.213	0.920	1.600	1.031	0.794	1.339
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.226*	1.015	1.480	1.198	0.993	1.445	1.274*	1.029	1.578	1.198	0.961	1.494
SEIFA quartile 3	1.436*	1.163	1.772	1.230	0.989	1.531	1.394*	1.100	1.767	1.148	0.888	1.484
SEIFA quartile 4	1.492*	1.156	1.925	1.276	0.978	1.664	1.453*	1.088	1.941	1.218	0.888	1.672
Unemployment%	1.084*	1.038	1.133	1.055*	1.004	1.109	1.076*	1.024	1.130	1.051	0.994	1.111
Indigenous%	1.159*	1.097	1.225	1.172*	1.103	1.245	1.149*	1.081	1.222	1.154*	1.076	1.237
Young males%	0.980	0.941	1.021	0.959	0.917	1.002	0.982	0.939	1.027	0.956	0.911	1.004
Male/female%	0.998	0.997	1.000	1.001	0.999	1.003	0.999	0.997	1.001	1.001	0.998	1.004
Mean age	1.017	0.988	1.047	0.979	0.949	1.011	1.007	0.976	1.039	0.977	0.944	1.011
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.68: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic, socio-economic status and traffic signal zone, at postcode-level, in Perth Metropolitan Area between 2004/05 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets	0.995	0.984	1.006	0.995	0.984	1.006
On-premise sales#/outlet	1.007	0.943	1.076	1.036	0.962	1.116
Off-premise sales#/outlet	1.019*	1.007	1.032	1.017*	1.002	1.032
1,500m+ between traffic signals^	1.000			1.000		
1,000m -1,500m between signals	0.807	0.581	1.122	0.907	0.665	1.238
300m-1,000m between signals	1.084	0.884	1.330	1.103	0.907	1.340
Up to 300m between signals	1.398*	1.032	1.895	1.353*	1.009	1.813
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.979	0.918	1.043	0.997	0.926	1.073
SEIFA quartile 3	0.918	0.832	1.012	0.918	0.824	1.021
SEIFA quartile 4	0.989	0.872	1.121	0.957	0.836	1.097
Unemployment%	0.992	0.985	1.000	0.987*	0.979	0.996
Indigenous%	1.022*	1.015	1.029	1.020*	1.012	1.028
Young males%	1.035*	1.003	1.067	1.023	0.989	1.058
Male/female%	1.000	0.994	1.006	1.001	0.995	1.007
Mean age	1.005	0.971	1.041	0.990	0.956	1.026
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.69: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, adjusting for demographic, socio-economic status and traffic signal zone, at suburb-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries						Weekend Night2 injuries					
	2002/03 to 2009/10			2004/05 to 2009/10			2002/03 to 2009/10			2004/05 to 2009/10		
Within 5km of centroid	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Count of on-premise outlets	1.000	0.999	1.001	1.001	1.000	1.002	1.001	1.000	1.002	1.001	1.000	1.002
Count of off-premise outlets	1.000	0.986	1.014	0.990	0.977	1.003	0.990	0.976	1.005	0.983*	0.969	0.997
On-premise sales#/outlet	0.992	0.956	1.028	1.007	0.973	1.043	0.984	0.944	1.025	0.992	0.952	1.034
Off-premise sales#/outlet	1.007*	1.001	1.013	1.002	0.996	1.008	1.005	0.998	1.013	1.001	0.994	1.008
1,500m+ between traffic signals^	1.000			1.000			1.000			1.000		
1,000m -1,500m between signals	1.010	0.661	1.543	0.936	0.629	1.392	0.936	0.600	1.460	0.898	0.585	1.378
300m-1,000m between signals	1.188	0.937	1.505	1.094	0.877	1.365	1.152	0.904	1.467	1.118	0.885	1.412
Up to 300m between signals	1.354*	1.013	1.810	1.191	0.908	1.564	1.282	0.954	1.722	1.166	0.878	1.548
SEIFA quartile 1^	1.000			1.000			1.000			1.000		
SEIFA quartile 2	1.211*	1.003	1.462	1.209	1.000	1.461	1.248*	1.009	1.543	1.185	0.950	1.478
SEIFA quartile 3	1.400*	1.131	1.732	1.250*	1.002	1.561	1.386*	1.093	1.758	1.172	0.907	1.515
SEIFA quartile 4	1.451*	1.121	1.879	1.310*	1.001	1.715	1.453*	1.085	1.945	1.269	0.924	1.742
Unemployment%	1.080*	1.033	1.129	1.059*	1.008	1.113	1.077*	1.026	1.132	1.061*	1.004	1.121
Indigenous%	1.158*	1.096	1.224	1.164*	1.095	1.238	1.141*	1.073	1.214	1.138*	1.061	1.221
Young males%	0.984	0.944	1.026	0.961	0.919	1.005	0.985	0.941	1.031	0.956	0.910	1.005
Male/female%	0.998	0.997	1.000	1.001	0.999	1.003	0.998	0.996	1.000	1.001	0.998	1.004
Mean age	1.020	0.991	1.050	0.983	0.951	1.016	1.011	0.979	1.043	0.981	0.947	1.016
ERP 15+	(exposure)			(exposure)			(exposure)			(exposure)		

#Sales in 10,000l * $p<0.05$ ^Reference group ERP 15+: Estimated Resident Population 15 years and older

10.10.6 Models including outlets by category of trading hours

Table 10.70: Panel model results for counts of on- and off-premise outlets by trading hours (three categories), at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (weekend extended trading hours)	1.070*	1.040	1.100	1.075*	1.041	1.110
Count of on-premise outlets (weekday and weekend extended trading hours)	1.044	1.000	1.089	1.062*	1.012	1.114
Count of on-premise outlets (no extended trading hours)	1.006*	1.001	1.011	1.007*	1.002	1.013
Count of off-premise outlets (weekend extended trading hours)	0.886	0.778	1.009	0.901	0.782	1.038
Count of off-premise outlets (weekday and weekend extended trading hours)	1.000			1.000		
Count of off-premise outlets (no extended trading hours)	1.135*	1.093	1.178	1.154*	1.109	1.201

* p<0.05

Table 10.71: Panel model results for sales at on- and off-premise outlets by trading hours (three categories), at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet (weekend extended trading hours)	0.977	0.943	1.012	0.984	0.947	1.021
On-premise sales#/outlet (weekday and weekend extended trading hours)	1.057	0.992	1.126	1.077*	1.007	1.152
On-premise sales#/outlet (no extended trading hours)	1.025	0.981	1.071	1.015	0.968	1.065
Off-premise sales#/outlet (weekend extended trading hours)	0.943	0.867	1.026	0.937	0.854	1.029
Off-premise sales#/outlet (weekday and weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.037*	1.023	1.052	1.039*	1.023	1.055

Sales in 10,000 litres * $p<0.05$

Table 10.72: Panel model results for sales and counts of on- and off-premise outlets by trading hours (three categories), adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (weekend extended trading hours)	1.065*	1.034	1.097	1.064*	1.030	1.098
Count of on-premise outlets (weekday and weekend extended trading hours)	0.999	0.947	1.053	1.011	0.953	1.072
Count of on-premise outlets (no extended trading hours)	1.006*	1.002	1.011	1.009*	1.004	1.013
Count of off-premise outlets (weekend extended trading hours)	0.667*	0.530	0.841	0.665*	0.515	0.859
Count of off-premise outlets (weekday and weekend extended trading hours)	1.000			1.000		
Count of off-premise outlets (no extended trading hours)	0.960*	0.935	0.986	0.966*	0.942	0.991
On-premise sales#/outlet (weekend extended trading hours)	0.973	0.946	1.000	0.980	0.952	1.010
On-premise sales#/outlet (weekday and weekend extended trading hours)	1.006	0.952	1.063	0.998	0.940	1.060
On-premise sales#/outlet (no extended trading hours)	1.030	0.994	1.066	1.031	0.993	1.070
Off-premise sales#/outlet (weekend extended trading hours)	1.127	0.996	1.275	1.121	0.978	1.284
Off-premise sales#/outlet (weekday and weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.020*	1.006	1.033	1.021*	1.006	1.035
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.922	0.808	1.051	0.859*	0.764	0.966
CBD to 7km	1.215*	1.023	1.444	1.025	0.887	1.186
CBD	0.796	0.352	1.799	0.448*	0.217	0.927
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.980	0.900	1.068	1.003	0.917	1.098
SEIFA quartile 3	0.993	0.875	1.127	0.992	0.870	1.130
SEIFA quartile 4	1.251*	1.057	1.480	1.182	0.992	1.408

Unemployment%	0.982*	0.973	0.992	0.975*	0.964	0.986
Indigenous%	1.236*	1.174	1.301	1.216*	1.154	1.282
Young males%	0.963*	0.943	0.984	0.962*	0.941	0.984
Male/female%	0.993*	0.988	0.997	0.993*	0.989	0.998
Mean age	0.992	0.982	1.002	0.991	0.980	1.002
ERP 15+	(exposure)			(exposure)		

#Sales in 10,000l * p<0.05 ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.73: Panel model results for counts of on- and off-premise outlets by trading hours, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.063*	1.035	1.093	1.072*	1.040	1.105
Count of on-premise outlets (no extended trading hours)	1.004	1.000	1.009	1.007*	1.002	1.012
Count of off-premise outlets (extended trading hours)	0.887	0.778	1.011	0.902	0.782	1.039
Count of off-premise outlets (no extended trading hours)	1.134*	1.092	1.178	1.154*	1.108	1.201

* p<0.05

Table 10.74: Panel model results for sales at on- and off-premise outlets by trading hours, at postcode-level, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet (extended trading hours)	0.979	0.945	1.014	0.986	0.949	1.024
On-premise sales#/outlet (no extended trading hours)	1.035	0.991	1.081	1.026	0.978	1.077
Off-premise sales#/outlet (extended trading hours)	0.940	0.864	1.023	0.934	0.850	1.025
Off-premise sales#/outlet (no extended trading hours)	1.038*	1.024	1.052	1.039*	1.023	1.055

Sales in 10,000 litres * p<0.05

Table 10.75: Panel model results for sales and counts of on- and off-premise outlets by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.052*	1.021	1.083	1.054*	1.021	1.088
Count of on-premise outlets (no extended trading hours)	1.005	1.000	1.009	1.008*	1.003	1.012
Count of off-premise outlets (extended trading hours)	0.679*	0.539	0.855	0.677*	0.524	0.873
Count of off-premise outlets (no extended trading hours)	0.959*	0.934	0.986	0.966*	0.942	0.991
On-premise sales#/outlet (extended trading hours)	0.980	0.954	1.007	0.986	0.958	1.014
On-premise sales#/outlet (no extended trading hours)	1.028	0.993	1.064	1.029	0.992	1.067
Off-premise sales#/outlet (extended trading hours)	1.118	0.988	1.265	1.112	0.971	1.275
Off-premise sales#/outlet (no extended trading hours)	1.019*	1.006	1.033	1.020*	1.006	1.035
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.930	0.813	1.065	0.862*	0.766	0.969
CBD to 7km	1.247*	1.043	1.492	1.033	0.892	1.197
CBD	0.907	0.379	2.168	0.472*	0.224	0.997
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.984	0.903	1.072	1.005	0.918	1.099
SEIFA quartile 3	1.019	0.899	1.155	1.006	0.884	1.146
SEIFA quartile 4	1.276*	1.078	1.510	1.188	0.998	1.416
Unemployment%	0.983*	0.974	0.993	0.976*	0.966	0.987
Indigenous%	1.245*	1.182	1.311	1.221*	1.158	1.287
Young males%	0.964*	0.943	0.985	0.963*	0.942	0.985
Male/female%	0.993*	0.988	0.997	0.993*	0.988	0.998
Mean age	0.992	0.982	1.002	0.992	0.981	1.003
ERP 15+	(exposure)			(exposure)		

[#]Sales in 10,000l [*] $p<0.05$ [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.76: Panel model results for counts of on- and off-premise outlets within 1km of the geographic centroid, by trading hours (three categories), in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (weekend extended trading hours)	1.046*	1.010	1.082	1.044*	1.003	1.085
Count of on-premise outlets (weekday and weekend extended trading hours)	0.975	0.921	1.032	0.992	0.927	1.062
Count of on-premise outlets (no extended trading hours)	1.010*	1.005	1.015	1.011*	1.006	1.016
Count of off-premise outlets (weekend extended trading hours)	1.089	0.715	1.659	0.890	0.535	1.480
Count of off-premise outlets (weekday and weekend extended trading hours)	1.000			1.000		
Count of off-premise outlets (no extended trading hours)	0.994	0.937	1.056	0.990	0.933	1.050
On-premise sales#/outlet (weekend extended trading hours)	1.011	0.959	1.065	1.002	0.946	1.061
On-premise sales#/outlet (weekday and weekend extended trading hours)	1.096*	1.008	1.192	1.067	0.972	1.170
On-premise sales#/outlet (no extended trading hours)	1.014	0.996	1.033	1.010	0.991	1.030
Off-premise sales#/outlet (weekend extended trading hours)	0.978	0.796	1.202	1.034	0.809	1.322
Off-premise sales#/outlet (weekday and weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.009	0.997	1.022	1.012	0.999	1.025
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.923	0.805	1.059	0.863*	0.760	0.981
CBD to 7km	1.142	0.943	1.384	0.986	0.829	1.173
CBD	0.335*	0.118	0.953	0.205*	0.077	0.545
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.984	0.904	1.071	1.011	0.923	1.107
SEIFA quartile 3	1.010	0.891	1.146	1.022	0.895	1.167
SEIFA quartile 4	1.280*	1.086	1.509	1.233*	1.036	1.469

Unemployment%	0.985*	0.975	0.994	0.977*	0.966	0.988
Indigenous%	1.228*	1.169	1.290	1.216*	1.154	1.280
Young males%	0.961*	0.941	0.981	0.961*	0.940	0.982
Male/female%	0.993*	0.988	0.997	0.992*	0.988	0.997
Mean age	0.993	0.983	1.003	0.993	0.982	1.004
ERP 15+	(exposure)			(exposure)		

[#]Sales in 10,000l [*] p<0.05 [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.77: Panel model results for counts of on- and off-premise outlets within 1km of the geographic centroid, by trading hours, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.061*	1.028	1.095	1.075*	1.036	1.116
Count of on-premise outlets (no extended trading hours)	1.002	0.997	1.008	1.006	0.999	1.012
Count of off-premise outlets (extended trading hours)	1.244*	1.020	1.517	1.138	0.908	1.426
Count of off-premise outlets (no extended trading hours)	1.237*	1.150	1.331	1.260*	1.163	1.364

* $p<0.05$

Table 10.78**:** Panel model results for sales at on- and off-premise outlets within 1km of the geographic centroid, by trading hours, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet (extended trading hours)	1.060*	1.008	1.115	1.063*	1.004	1.126
On-premise sales#/outlet (no extended trading hours)	1.025*	1.003	1.047	1.022	0.998	1.047
Off-premise sales#/outlet (extended trading hours)	1.057	0.951	1.174	1.021	0.908	1.148
Off-premise sales#/outlet (no extended trading hours)	1.033*	1.020	1.046	1.035*	1.020	1.049

Sales in 10,000 litres * $p<0.05$

Table 10.79: Panel model results for sales and counts of on- and off-premise outlets within 1km of the geographic centroid by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 1km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.016	0.973	1.061	1.030	0.984	1.077
Count of on-premise outlets (no extended trading hours)	1.005	0.999	1.010	1.008*	1.003	1.014
Count of off-premise outlets (extended trading hours)	0.987	0.639	1.524	0.790	0.468	1.336
Count of off-premise outlets (no extended trading hours)	0.975	0.917	1.036	0.977	0.923	1.035
On-premise sales#/outlet (extended trading hours)	1.023	0.974	1.075	1.006	0.954	1.060
On-premise sales#/outlet (no extended trading hours)	1.009	0.991	1.027	1.006	0.986	1.025
Off-premise sales#/outlet (extended trading hours)	1.046	0.845	1.294	1.122	0.872	1.444
Off-premise sales#/outlet (no extended trading hours)	1.011	0.998	1.024	1.012	0.999	1.026
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.039	0.893	1.209	0.928	0.818	1.053
CBD to 7km	1.279*	1.036	1.579	1.028	0.867	1.220
CBD	0.884	0.225	3.468	0.317*	0.109	0.918
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.852*	0.783	0.927	0.854*	0.783	0.931
SEIFA quartile 3	0.779*	0.692	0.877	0.757*	0.676	0.847
SEIFA quartile 4	0.925	0.786	1.089	0.842*	0.722	0.981
Unemployment%	0.968*	0.961	0.975	0.962*	0.954	0.969
Indigenous%	1.024*	1.019	1.030	1.021*	1.015	1.028
Young males%	0.980	0.959	1.001	0.979	0.958	1.000
Male/female%	0.999	0.996	1.002	0.999	0.996	1.002
Mean age	0.995	0.985	1.005	0.994	0.983	1.006

ERP 15+		(exposure)	(exposure)

[#]Sales in 10,000l [*] $p<0.05$ [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.80: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid, by trading hours (three categories), adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 2km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (weekend extended trading hours)	1.034*	1.011	1.057	1.033*	1.007	1.060
Count of on-premise outlets (weekday and weekend extended trading hours)	0.992	0.956	1.030	1.004	0.963	1.048
Count of on-premise outlets (no extended trading hours)	1.004*	1.001	1.007	1.004*	1.001	1.007
Count of off-premise outlets (weekend extended trading hours)	1.009	0.868	1.174	0.923	0.780	1.092
Count of off-premise outlets (weekday and weekend extended trading hours)	1.000			1.000		
Count of off-premise outlets (no extended trading hours)	0.972	0.945	1.001	0.975	0.948	1.004
On-premise sales#/outlet (weekend extended trading hours)	0.961	0.863	1.068	0.962	0.854	1.083
On-premise sales#/outlet (weekday and weekend extended trading hours)	1.054	0.851	1.306	1.014	0.796	1.292
On-premise sales#/outlet (no extended trading hours)	1.044*	1.006	1.084	1.041	1.000	1.084
Off-premise sales#/outlet (weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (weekday and weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.006	0.991	1.022	1.001	0.985	1.018
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.943	0.820	1.084	0.884	0.776	1.008
CBD to 7km	1.190	0.968	1.464	1.024	0.849	1.235
CBD	0.845	0.406	1.756	0.593	0.300	1.171
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.993	0.912	1.082	1.024	0.935	1.122
SEIFA quartile 3	1.048	0.923	1.190	1.060	0.927	1.212
SEIFA quartile 4	1.309*	1.106	1.549	1.269*	1.059	1.520
Unemployment%	0.984*	0.974	0.993	0.976*	0.965	0.987

Indigenous%	1.237*	1.178	1.299	1.230*	1.168	1.295
Young males%	0.961*	0.941	0.981	0.960*	0.939	0.982
Male/female%	0.992*	0.987	0.996	0.991*	0.986	0.996
Mean age	0.993	0.983	1.003	0.993	0.982	1.004
ERP 15+	(exposure)			(exposure)		

[#]Sales in 10,000l [*] p<0.05 [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.81: Panel model results for counts of on- and off-premise outlets within 2km of the geographic centroid, by trading hours, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.030*	1.011	1.049	1.039*	1.016	1.062
Count of on-premise outlets (no extended trading hours)	0.998	0.995	1.001	0.999	0.995	1.002
Count of off-premise outlets (extended trading hours)	1.142	0.969	1.347	1.040	0.857	1.263
Count of off-premise outlets (no extended trading hours)	1.171*	1.127	1.216	1.173*	1.124	1.225

[*] p<0.05

Table 10.82: Panel model results for sales at on- and off-premise outlets within 2km of the geographic centroid, by trading hours, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet (extended trading hours)	1.113	0.993	1.248	1.116	0.981	1.270
On-premise sales#/outlet (no extended trading hours)	1.065*	1.020	1.112	1.057*	1.007	1.110
Off-premise sales#/outlet (extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.030*	1.012	1.048	1.025*	1.005	1.045

Sales in 10,000 litres * $p<0.05$

Table 10.83: Panel model results for sales and counts of on- and off-premise outlets within 2km of the geographic centroid by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 2km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.020	0.995	1.046	1.023	0.995	1.050
Count of on-premise outlets (no extended trading hours)	1.002	0.999	1.004	1.003	1.000	1.006
Count of off-premise outlets (extended trading hours)	1.069	0.918	1.244	0.982	0.831	1.161
Count of off-premise outlets (no extended trading hours)	0.973	0.944	1.003	0.978	0.951	1.006
On-premise sales#/outlet (extended trading hours)	0.952	0.854	1.062	0.945	0.839	1.065
On-premise sales#/outlet (no extended trading hours)	1.035	0.997	1.074	1.032	0.991	1.074
Off-premise sales#/outlet (extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.005	0.990	1.021	1.001	0.985	1.017
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.063	0.906	1.248	0.951	0.831	1.087
CBD to 7km	1.343*	1.056	1.709	1.063	0.877	1.290
CBD	1.434	0.615	3.343	0.799	0.398	1.604
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.856*	0.786	0.932	0.858*	0.786	0.936
SEIFA quartile 3	0.793*	0.701	0.897	0.765*	0.679	0.861
SEIFA quartile 4	0.952	0.803	1.128	0.859	0.729	1.012
Unemployment%	0.967*	0.960	0.974	0.960*	0.953	0.968
Indigenous%	1.024*	1.018	1.030	1.021*	1.014	1.028
Young males%	0.980	0.959	1.000	0.979	0.958	1.000
Male/female%	0.999	0.996	1.002	0.998	0.995	1.001
Mean age	0.995	0.984	1.005	0.994	0.983	1.005

ERP 15+	(exposure)	(exposure)

#Sales in 10,000l * $p<0.05$ ^ Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.84: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid, by trading hours (three categories), adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area, at postcode-level, between 2002/03 and 2009/10

Within 5km of centroid	Night2 injuries			Weekend Night2 injuries		
	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (weekend extended trading hours)	1.006	0.997	1.015	1.007	0.997	1.017
Count of on-premise outlets (weekday and weekend extended trading hours)	0.990	0.978	1.002	0.993	0.979	1.007
Count of on-premise outlets (no extended trading hours)	1.001	1.000	1.002	1.001	0.999	1.002
Count of off-premise outlets (weekend extended trading hours)	0.933	0.868	1.003	0.916*	0.847	0.991
Count of off-premise outlets (weekday and weekend extended trading hours)	1.000			1.000		
Count of off-premise outlets (no extended trading hours)	0.997	0.986	1.008	0.997	0.986	1.008
On-premise sales#/outlet (weekend extended trading hours)	1.028	0.890	1.187	1.005	0.855	1.181
On-premise sales#/outlet (weekday and weekend extended trading hours)	1.137	0.947	1.365	1.127	0.914	1.390
On-premise sales#/outlet (no extended trading hours)	1.036	0.997	1.076	1.176*	1.057	1.308
Off-premise sales#/outlet (weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (weekday and weekend extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.034*	1.005	1.063	1.022	0.992	1.052
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	0.921	0.782	1.085	0.852*	0.729	0.996
CBD to 7km	1.157	0.886	1.512	1.017	0.795	1.302
CBD	1.815	0.911	3.614	1.473	0.761	2.850
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.983	0.901	1.071	1.022	0.933	1.120
SEIFA quartile 3	1.038	0.914	1.179	1.066	0.932	1.218
SEIFA quartile 4	1.308*	1.108	1.544	1.308*	1.095	1.562
Unemployment%	0.981*	0.971	0.991	0.975*	0.963	0.987

Indigenous%	1.238*	1.177	1.302	1.231*	1.168	1.298
Young males%	0.962*	0.941	0.983	0.960*	0.938	0.982
Male/female%	0.994*	0.989	0.998	0.993*	0.989	0.998
Mean age	0.992	0.982	1.002	0.991	0.980	1.002
ERP 15+	(exposure)			(exposure)		

[#]Sales in 10,000l [*] p<0.05 [^] Reference group ERP 15+: Estimated Resident Population 15 years and older

Table 10.85: Panel model results for count of on- and off-premise outlets within 5km of the geographic centroid, by trading hours, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	1.004	0.997	1.012	1.007	0.998	1.016
Count of on-premise outlets (no extended trading hours)	0.998*	0.997	0.999	0.998*	0.997	0.999
Count of off-premise outlets (extended trading hours)	0.959	0.888	1.036	0.937	0.856	1.025
Count of off-premise outlets (no extended trading hours)	1.069*	1.056	1.083	1.065*	1.050	1.080

Table 10.86: Panel model results for sales per on- and off-premise outlets within 5km of the geographic centroid, by trading hours, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
On-premise sales#/outlet (extended trading hours)	1.159*	1.018	1.319	1.126	0.969	1.309
On-premise sales#/outlet (no extended trading hours)	1.475*	1.293	1.682	1.518*	1.317	1.750
Off-premise sales#/outlet (extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.132*	1.094	1.172	1.123*	1.082	1.167

Sales in 10,000 litres *p<0.05

Table 10.87: Panel model results for sales and counts of on- and off-premise outlets within 5km of the geographic centroid by trading hours, adjusting for demographic and socio-economic status, and distance from the CBD, in Perth Metropolitan Area between 2002/03 and 2009/10

	Night2 injuries			Weekend Night2 injuries		
Within 5km of centroid	IRR	95% CI		IRR	95% CI	
Count of on-premise outlets (extended trading hours)	0.997	0.988	1.006	0.999	0.989	1.009
Count of on-premise outlets (no extended trading hours)	1.000	0.999	1.001	1.000	0.999	1.001
Count of off-premise outlets (extended trading hours)	0.954	0.890	1.023	0.944	0.874	1.019
Count of off-premise outlets (no extended trading hours)	0.990	0.978	1.003	0.992	0.981	1.004
On-premise sales#/outlet (extended trading hours)	1.050	0.923	1.193	1.035	0.898	1.192
On-premise sales#/outlet (no extended trading hours)	1.130*	1.020	1.252	1.167*	1.048	1.299
Off-premise sales#/outlet (extended trading hours)	1.000			1.000		
Off-premise sales#/outlet (no extended trading hours)	1.014	0.986	1.044	1.005	0.975	1.035
15km+ from CBD^	1.000			1.000		
7km to 15km from CBD	1.117	0.917	1.361	0.984	0.826	1.173
CBD to 7km	1.765*	1.242	2.508	1.351*	1.001	1.824
CBD	3.057*	1.376	6.794	2.268*	1.099	4.677
SEIFA quartile 1^	1.000			1.000		
SEIFA quartile 2	0.873*	0.801	0.952	0.883*	0.807	0.966
SEIFA quartile 3	0.835*	0.737	0.947	0.818*	0.720	0.929
SEIFA quartile 4	1.041	0.881	1.231	0.982	0.823	1.171
Unemployment%	0.965*	0.958	0.972	0.959*	0.951	0.967
Indigenous%	1.025*	1.018	1.031	1.021*	1.014	1.028
Young males%	0.982	0.961	1.003	0.980	0.959	1.003
Male/female%	0.999	0.996	1.002	0.999	0.996	1.002
Mean age	0.994	0.984	1.004	0.993	0.982	1.005

ERP 15+	(exposure)	(exposure)

[#]Sales in 10,000l [*] $p<0.05$ [^] Reference group ERP 15+: Estimated Resident Population 15 years and older