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**The effects of changes in the availability of alcohol
on consumption, health and social problems**

Michael Livingston

*Submitted in total fulfilment of the requirements of the degree of
Doctor of Philosophy*

July 2012

School of Population Health

The University of Melbourne

Abstract

Following a long period of relative stability, the liquor licensing regime in Victoria, Australia underwent two decades of dramatic liberalisation from the late 1980s. This liberalisation of policy resulted in a sharp expansion of the number of alcohol outlets in the state. Given the previous studies that have shown links between the density of alcohol outlets and rates of alcohol-related problems, it could be predicted that this expansion of outlet numbers would have contributed to increases in a range of alcohol-related problems.

The empirical work of this thesis examines whether this is the case. Initial analyses of state-level data find sharp increases in rates of a range of health and social problems related to alcohol during the period of industry expansion. However, there was no indication in any of the survey data available for Victoria that patterns of consumption had changed markedly over the same period.

To test whether the harm trends were indicative of a relationship between outlet density and alcohol problems, a series of small-area spatial studies were undertaken. These studies used spatial statistical methods that deal with the potential problems of using spatial units to model data at the postcode level. These models assessed whether areas with higher densities of outlets experienced higher rates of harm and whether changes in local-level outlet densities were associated with changes in local-level rates of harm. Cross-sectional findings pointed to higher rates of heavy drinking among young adults and higher rates of violence in areas with higher densities of alcohol outlets. Longitudinally, the density of outlets was significantly and positively associated with rates of general assault, domestic violence, assault-related hospitalisations and alcohol-attributable disease rates.

Importantly, different types of outlets were important depending on the types of harm examined and the types of neighbourhood focussed on. Broadly speaking, the density of general licence outlets (pubs/hotels) had the strongest association with assault rates, while packaged licence outlets (bottle shops) were more strongly associated with domestic violence and alcohol-attributable disease. These effects varied based on neighbourhood characteristics with, for example, general outlets most related to assault rates in the inner-city areas, while packaged liquor outlets were more associated with assaults in suburban parts of Melbourne.

An additional set of studies examined the distribution of alcohol outlets across Victoria, finding substantial socio-economic inequalities. In particular, packaged liquor outlets were shown to cluster in socio-economically disadvantaged areas. Over the period of liquor deregulation in Victoria, these inequalities have remained substantially unchanged, with the exception of general licence outlets (pubs), which are disproportionately located in inner-city areas that have been the subject of comprehensive gentrification.

Overall, the findings of this thesis point to significant impacts of the sharp growth of liquor licences in Victoria on alcohol-related harm. These findings have serious implications for licensing policy both in Australia and internationally, suggesting that liberalised licensing policies bring with them substantial health and social costs.

Declaration

This is to certify that:

(i) the thesis comprises only my original work towards the PhD except where indicated in the Preface,

(ii) due acknowledgement has been made in the text to all other material used,

(iii) the thesis is fewer than 100,000 words in length, exclusive of tables, maps, bibliographies.

Michael Livingston

Preface

This thesis includes a range of material previously published in the academic literature, although in all cases the material presented in the thesis substantially extends the work that appears in the published papers. Signed statements regarding contributions to multi-authored papers have been included with the submission of this dissertation.

The work examining trends in alcohol consumption and related harm presented in Chapter 3 is based on two previously published articles:

- Livingston M. Recent trends in risky alcohol consumption and related harm among young people in Victoria, Australia. *Australian and New Zealand Journal of Public Health*. 2008;32(3):266-71.
- Livingston M, Matthews S, Barratt MJ, Lloyd B, Room R. Diverging trends in alcohol consumption and alcohol-related harm in Victoria. *Australian and New Zealand Journal of Public Health*. 2010;34(4):368-73.

In terms of the multi-authored publication, the conceptualisation, the majority of the writing and the final data analysis was undertaken by Michael Livingston. Some of the initial data extraction and analysis was undertaken by Sharon Matthews and Monica Barratt. Access to the data was facilitated by Belinda Lloyd, who also provided key advice on the strengths and limitations of the various data sources. Robin Room provided key conceptual advice and wrote sections of the paper's conclusions which have not been included in the thesis verbatim.

Chapter 4 is based on a paper published with two co-authors:

- Livingston M, Laslett AM, Dietze P. Individual and community correlates of young people's high-risk drinking in Victoria, Australia. *Drug and Alcohol Dependence*. 2008;98(3):241-8.

This publication was conceptualised by all three authors. The analysis and some of the writing was undertaken by Michael Livingston. Data extraction and manuscript revisions were undertaken by Anne-Marie Laslett. Paul Dietze wrote the introduction and conclusion sections of the paper, which have been substantially replaced in the material presented here.

Chapter 5 builds on work from two previously published papers examining the link between alcohol outlet density and violence:

- Livingston M. Alcohol outlet density and assault: a spatial analysis. *Addiction*. 2008;103(4):619-28.

- Livingston M. A longitudinal analysis of alcohol outlet density and assault. *Alcoholism: Clinical and Experimental Research*. 2008;32(6):1074-9.

Chapter 6 incorporates material from one previously published paper:

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

Chapter 7 includes material taken from a paper currently accepted for publication but yet to actually be published:

- Livingston M. The social gradient of alcohol availability in Victoria, Australia. *Australian and New Zealand Journal of Public Health*. In press.

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This thesis would never have been completed (or even commenced) without the unstinting enthusiasm and support of my two supervisors Robin Room and Paul Dietze. They brought me into the field, gave me a year or so to orient myself and then finally convinced me that I should tackle the PhD I'd been avoiding my entire career. Working with Robin has been a comprehensive education - his depth of knowledge, breadth of interests and willingness to spend time and energy on every piece of this project have provided with a research training experience that extends far beyond this dissertation. Paul's encyclopaedic knowledge of Victorian alcohol policy and epidemiology were critical to the conception of this project and his championing of my work and career has been unwavering. Between them they were the perfect supervision team: Robin thinking of new and imaginative ways to expand and extend this project and Paul letting me know when enough was enough. I'm honoured to consider them both my colleagues and my friends.

The ability to take this project on in a concerted, full-time way was only made possible by the generous funding provided by a scholarship I was awarded by the Sidney Myer Fund and IOR Ltd. This scholarship is the main reason that the thesis is being submitted now, rather than in 2015. Along with the financial support, the enthusiasm of the Sidney Myer and IOR representatives at the various scholarship events has been gratifying and motivating.

I would also like to thank my colleagues and friends past and present at Turning Point Alcohol and Drug Centre. Turning Point has been a wonderful environment for a researcher learning his trade – I've been lucky to work with people with an amazingly diverse set of skills and interest and thank them all for my continuing education in alcohol and drug research. In particular, Claire, Jason, Anne-Marie, Amy, Jason, Jacqui, Sarah, Angela and Sharon have been generous in their support: reading drafts, answering my questions, brainstorming ideas, listening to me complain and generally being the best damn team of collaborators I can imagine. Amongst my fellow PhD students at the University of Melbourne, Gemma Carey provided invaluable friendship and support. Thanks in particular for helping me navigate the complexities of the university's systems and for arranging semi-regular PhD student social events to divert us all from the hard slog of the thesis. I also need to acknowledge the encouragement and advice I've had from researchers, policy-makers and others in the field from across a wide-range of organisations. They are too many to mention,

but their enthusiasm has helped to reinforce the value of my work and kept me on track when things got difficult.

The support of my family throughout my education has been invaluable. In particular, Mum has been steadfast in her support of my studies, for which I can't thank her enough. Nobody will be more excited that I have finally finished studying than she will. Thanks also to all my friends, who have balanced supportive interest with irrelevant distractions across the last four years. It's ironic how many conversations about liquor licensing I've ended up having in pubs.

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Chapter 1. Introduction

Alcohol consumption and alcohol-related harm are pressing political issues in Australia, with federal and state governments increasingly focussed on addressing binge-drinking, alcohol-related violence and other problems, with a particular focus on young people. At the national level, the recently convened National Preventative Health Taskforce included alcohol as one of the three public health issues in need of action (along with tobacco and obesity) (1), while in 2008, the federal government introduced a special tax on ‘alcopops’ to reduce drinking, particularly amongst young people (2). In Victoria, the former state government released the Victorian Alcohol Action Plan (3), which laid out a series of strategies aimed to reduce the harm associated with alcohol in the state. As suggested in the plan, the government has set up a new unit within the Department of Justice (Responsible Alcohol Victoria) to focus on issues around liquor licensing and employed a substantial new force of 40 liquor licensing inspectors.

This political concern is warranted; with alcohol misuse a major health and social problem in Australia. Begg et al. (4) estimated that in 2003, 3.2% of the burden of premature death, disease and injury in Australia was due to alcohol, while Collins and Lapsley (5) assessed the cost of alcohol misuse to Australian society in 2004/05 as \$15.3 billion. However, the recent political and public concern follows a long period of relaxed alcohol regulation and increased alcohol availability, particularly in Victoria.

This thesis is made up of a series of empirical studies examining the impact of these changes to alcohol availability in Victoria in the late 1990s and early 2000s, a period of rapid liquor licensing liberalisation. Data on broad trends in alcohol consumption and alcohol-related problems are presented, followed by a series of small-area studies (cross-sectional and longitudinal) of the association between the density of alcohol outlets and heavy alcohol consumption, general violence, domestic violence and chronic disease. Finally, the socio-economic distribution of alcohol outlets across Victoria is explored, including how this distribution was affected by the expansion of the alcohol industry in the last two decades. This introductory chapter will provide the context for the rest of the thesis, outlining the history of liquor licensing regulation in Victoria and then summarising the international research literature linking alcohol availability to alcohol consumption and related problems.

1.1. History of liquor licensing in Victoria

The empirical work of this thesis focuses entirely on changes in alcohol availability, alcohol consumption and alcohol-related harm over about a decade from the mid-1990s. This period captures the sharp increases in alcohol availability associated with legislative liberalisation in the late 1980s and 1990s, which will be described in detail below. These changes require some context. Thus, the following section will provide a brief history of liquor licensing and alcohol availability in Victoria, covering the period from 1900 through to 2007. This section will not delve deeply into the sociological or cultural factors underpinning the various regulatory shifts, as these have been covered in more depth elsewhere (6, 7), but will instead summarise the key regulatory developments in the licensing system in Victoria over the last century or so. It is worth noting that up until the 1970s, hotels (who were, and still are, able to sell alcohol for both on- and off-premise consumption) were the predominant source of alcohol sold in Victoria. For example, Merrett (8) reports that hotels accounted for around 80% of all alcohol purchases between 1917 and 1968. Thus, the regulation of liquor in Victoria has historically been largely the regulation of hotels.

The late 1800s saw the growth of a strong temperance movement across Australia (and indeed internationally) (9), leading to increasingly contested regulation of the alcohol industry. In Victoria, alcohol consumption peaked in the 1880s (10) and, under pressure from organised temperance organisations and a shift in public attitudes to drinking, the government began to implement more restrictive alcohol policies (11). For example, after relatively unrestrictive liquor licensing for most of the 1800s, the *Victorian Licensing Act, 1876* shifted control to the local level, requiring a poll of local ratepayers in an area before any new hotel licence was granted there. These restrictions were tightened further a decade later with the *Victorian Licensing Act, 1885*, which implemented statutory limits on the number of hotels in a municipality (4 for the first 1,000 residents and one for each subsequent 500 residents). In areas where the existing number of hotels exceeded these limits, the government began to slowly close down and compensate ‘excess’ hotels, resulting in the closure of more than 200 hotels between 1886 and 1902 (11). This trend continued with the establishment of the Licences Reduction Board (LRB) as part of the *Victorian Licensing Act, 1906*. The LRB’s main task was to close (and compensate) problematic or unprofitable hotels, resulting in the closure of more than 1,000 hotels in the decade following its introduction (12). The Act also legislated for polls on local option, resulting in votes for a reduction in licences in seventy-

one municipalities and a removal of all licences from two municipalities (Box Hill and Camberwell, parts of which remain without hotels to the current day).

The heavy regulation of the industry continued with the *Licensing Act, 1916*, which extended the life of the LRB, making it the sole Licensing Court for the state, and imposed strict 6pm closing hours for all hotels (11). However, with the influence of the temperance movement waning in the 1920s, the regulation of liquor in Victoria entered a kind of stasis. The LRB greatly reduced its efforts to close down hotels, instead focussing on improving the amenity of existing venues. This was formalised in the *Licensing Act, 1922* which explicitly gave the LRB the power to regulate the character of hotels, not just their number (8). The combination of the depression in the 1930s and the impacts of World War 2 in 1940s meant that there was little regulatory change over these two decades (although the reduction in hotel numbers continued due largely to the depression (8)).

In the post-war period, the influence of the temperance movement diminished further, and some parts of society began to chafe against the strict licensing restrictions (13). Numerous attempts were made to extend hotel trading hours from 6pm to 10pm, with the strongest push intended to secure extended trading hours in time for the 1956 Olympic Games in Melbourne. However, a referendum to achieve this was comprehensively defeated. This led to inactivity on the issue for a number of years, despite the Liberal Bolte government's desire to liberalise the system, which was demonstrated by numerous smaller legislative changes (such as the introduction of restaurant licences) (11).

In 1965, the Bolte Government avoided a second costly (and potentially unsuccessful) referendum, by ordering a Royal Commission into the way the alcohol was managed by the state. The Commission, headed by P. D. Phillips QC, returned unsurprising recommendations, including the extension of hotel trading hours until 10pm (14). The legislation enacted followed the majority of Phillips' recommendations, including the extension of trading hours, a continued emphasis on improving the standard of hotels and the implementation of blood alcohol content (BAC) limits for driving in Victoria. The new *Liquor Control Act, 1968* also set up the four-person Liquor Control Commission, headed by a County Court Judge, which was to be responsible for liquor licensing matters in Victoria until the late 1990s (15). An overlooked element of the new act was the removal of

restrictions on who could operate a retail bottled liquor licence, with the previous requirement that these could only be held by liquor wholesalers lifted. This stimulated the retail section of the liquor market substantially, with a doubling of the number of non-hotel packaged outlets between 1960 and 1975 (16, p27). This corresponded with a trebling in the proportion of beer sold by retail outlets, from 13% in 1964/65 to 31% in 1976/77 (16, p29).

The late 1960s and 1970s saw a gradual continuation of liquor law liberalisation, with the introduction and expansion of some of the smaller categories of liquor outlets (e.g. residential and tourist facilities), and extensions to late night trading for theatres and nightclubs. The ongoing relaxation of liquor regulation was temporarily halted in the early-1970s when the Hamer Government imposed minimum beer prices to prevent supermarket-owned packaged liquor outlets from loss-leading with packaged beer. It is worth noting that the intention of the minimum price was not to reduce consumption or improve public health, but to protect the hotels, who were being undercut by increasing packaged liquor sales, and thus, they claimed, were unable to provide the level of amenity required of them under the act (16).

In 1976, a further inquiry into the Liquor Control Act was instigated by the government. The inquiry was again headed by a lawyer, J. D. Davies QC, who recommended further liberalisation, particularly around trading hours (16). Many of Davies recommendations were implemented in the amendments to the Liquor Control Act passed in 1980, although pub trading hours were not extended to midnight, as proposed. The remainder of the 1980s saw minor political skirmishes on alcohol policy, with little in the way of significant change prior to the Cain government's commission of a comprehensive review of the *Liquor Control Act, 1968* in 1986.

Thus, the history of liquor licensing in Victoria from 1900 up to the 1980s can be seen in three broad phases (see Figure 1). The first phase, from 1900 up to about 1930, saw the implementation of restrictive alcohol policies driven by the influence of a politically engaged and popular temperance movement. This led, with the introduction of 6pm closing, to reduced trading hours but also to a sharp decline in the number of outlets selling alcohol in the state. The second phase, from 1930 to roughly 1960, was a period of stasis, with the influence of the temperance movement waning, but remaining powerful enough to prevent significant legislative changes. While there were declines in outlet numbers during the

depression, the overall approach to licensing changed little in this period. The third phase, from 1960 through the mid-1980s was a period of gradual liberalisation: trading hours were extended, the kinds of outlets permitted liquor licences was gradually expanded, and the number of outlets (especially non-pub outlets) rose slowly following the introduction of the 1968 Act. Thus, by the 1980s, Victoria had seen a largely stable licensing regime for around fifty years, with legislative shifts across the period leading to gradual and incremental liberalisation. This was to change with the sweeping legislative reforms made during the 1980s.

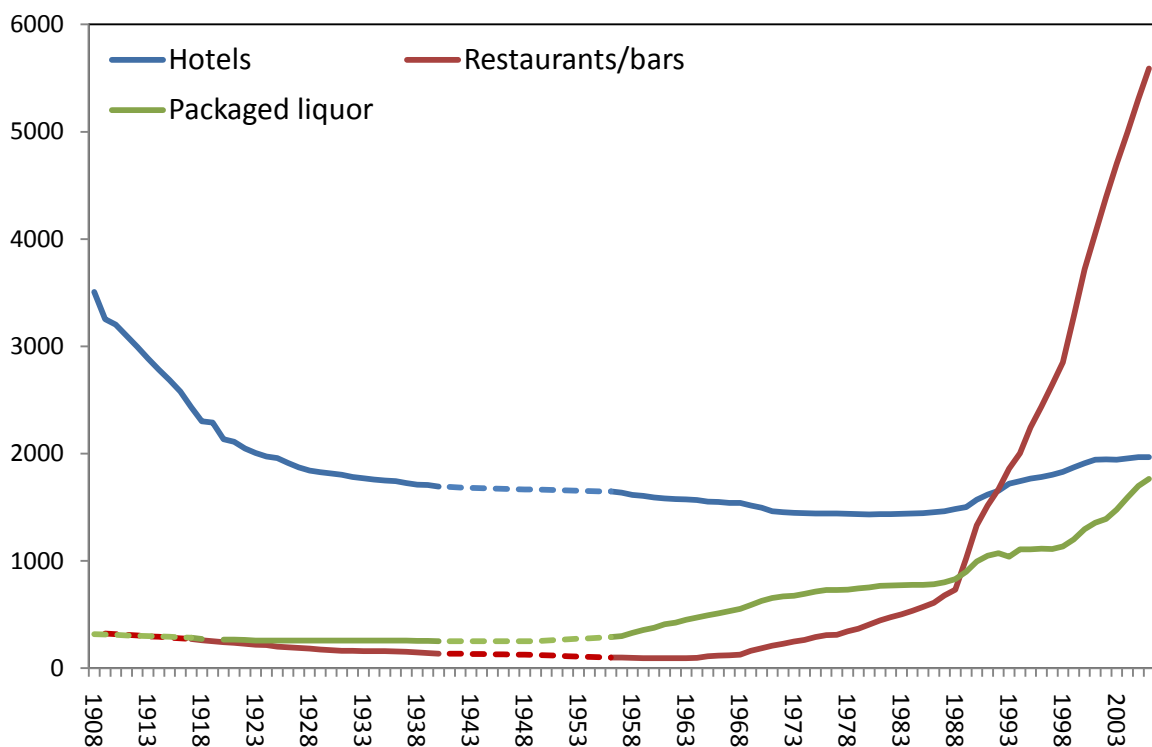


Figure 1 - Licensing trends in Victoria, 1908-2006 (sourced from annual liquor licensing reports, dotted lines represent data gaps)

The Cain Labor government came to power in 1982 with a substantial reform agenda, including an intention to make significant changes to the regulation of the alcohol industry (13). In 1984, the government commissioned Professor John Nieuwenhuysen, an economist based at the University of Melbourne, to conduct a complete review of the Liquor Control Act. As Zajdow discusses (17), the terms of the review laid out by the government set the direction of Nieuwenhuysen’s work, focussing on the interests of consumers, the liquor industry and the tourism industry. As might be expected given the terms of reference he was working under, Nieuwenhuysen’s Report advocated substantial deregulation of the liquor

market: a reduction in the number of licence types, the removal of a range of restrictions on the kinds of premises that could be licensed and a relaxation of restrictions on trading hours (12). In coming to these recommendations, Nieuwenhuysen dismissed the idea that licensing law could greatly impact on alcohol-related problems, instead advocating improved public information campaigns to educate the public and increased funding to non-licensing interventions such as random breath testing (12, p.5).

In dismissing licensing policy as a means for reducing alcohol-related harm, Nieuwenhuysen drew heavily on the two major reviews of Victorian liquor licensing discussed previously (14, 16). In particular, he supported Davies in rejecting the Lederman hypothesis, which broadly suggests that reductions to per-capita consumption will lead to reductions in heavy drinking and alcohol-related harm. Nieuwenhuysen rejected the policy implications of this hypothesis, which are that reductions in problems from alcohol are likely to result from population-level restrictions in availability or price. While issues relating to Lederman's specific distribution of consumption model were (and remain) contested at the time of Nieuwenhuysen's work, there existed at the time a growing body of international literature supporting the policy implications (18). Indeed, one of the key academic literature reviews cited in the Nieuwenhuysen Review in support of the argument that availability was not linked alcohol problems actually concludes the opposite (19). Regardless, Nieuwenhuysen expected his reforms to have little impact on the overall availability of alcohol, suggesting that, "the Review's proposals for change are unlikely to lead to much, if any, net increase in the number of premises where liquor is bought or consumed." (12, p. 7).

In 1988, the Cain Government implemented the majority of the recommendations of the Nieuwenhuysen Review in the *Liquor Control Act, 1987* (20). The act simplified the system drastically, halving the number of licensing categories and stripping away restrictions on particular licence types. For example, the 'on-premise' licence category could include restaurants, bars and other venues where alcohol could be purchased for on-premise consumption, effectively removing the previous requirement that restaurant licences supply alcohol only in conjunction with food. While the new Act followed the majority of Nieuwenhuysen's recommendations, it did not implement all of them. For example, the new Act continued to allow objections to new licences on the grounds of community need and there remained 8% caps on the proportion of the retail and hotel liquor markets that any one

entity could own (21). Contrary to Nieuwenhuysen's expectations, the new act had an immediate impact on alcohol availability, with licence numbers jumping sharply (see Figure 1). In particular, on-premise licences more than doubled between the introduction of the Act in 1987 and 1990. Thus, the reforms driven by the Nieuwenhuysen Review brought about a swift and dramatic expansion of the alcohol market in Victoria. This expansion was further facilitated by the ongoing liberalisation of liquor laws throughout the 1990s.

In 1993, the Kennett Government amended the *Liquor Control Act, 1987* primarily to facilitate the operation of bars at the newly opened Crown Casino. These amendments included the creation of a new category of licence allowing for the sale of alcohol without food in venues other than pubs – in other words, a bar or tavern licence. In addition, they made it easier for retail alcohol outlets to get extended trading permits allowing them to trade later than 11pm and extended standard Sunday closing hours from 8pm to 11pm. The next major step in the process of licensing liberalisation came in the late 1990s, driven by the newly enacted National Competition Policy (NCP) and the competition principles agreed to by all states via the Council of Australian Governments (COAG) in 1995 (22). Under the NCP, states were required to review all legislation that restricted competition and to ensure that the public benefits of these restrictions outweighed the costs. Liquor licensing was a key area reviewed by the National Competition Commission (NCC), with a number of states eventually fined for maintaining liquor acts deemed by the NCC to be anti-competitive (23). In response, the Victorian government commissioned a review of the *Liquor Control Act, 1987* in 1997 to examine whether changes were necessary to meet the NCC's requirements.

The review was tightly constrained by its terms of reference, which limited it entirely to the need for Victoria's liquor laws to comply with the NCP (21). In keeping with this focus, the review's recommendations were largely aimed at removing impediments to competition. This included recommending longer standard trading hours (to 1am), the removal of any 'needs' criterion for objections, the lifting of the remaining requirements related to food-service for on-premise outlets and the removal of the 8% cap on market-share in the general and packaged licence categories. In addition, the review recommended a general shift away from the licensing regulator and towards the use of local government planning powers to manage amenity issues associated with licensed premises (21). As with the previous inquiries into licensing, this review was not convinced that increasing the number of outlets (which they

acknowledged was a likely result of their recommendations) would result in increases in rates of alcohol-related harm. This was based in part on evidence of limited changes in per-capita consumption in Victoria following the sharp increases in availability following the 1987 Act (21, p19). The Victorian Government incorporated most of the recommendations of the review into the *Liquor Control Reform Act, 1998*, although the 8% cap on retail alcohol outlet ownership was maintained. The cap was intended to ensure diversity in the retail market by preventing the expansion of the major grocery chains, both of whom owned 8% of the market by this stage (24). The retention of the cap drew a critical response from the NCC, who threatened to withhold Victorian funding unless the cap was lifted (25). This pressure led to the Bracks' Government eventually agreeing to lift the 8% cap, which was gradually phased out between 2002 and 2006.

In summary, the twenty years up to 2006 were a tumultuous time in Victorian liquor licensing, with the regulatory regime undergoing a series of major reviews and substantial changes, including the introduction of two new licensing acts in 1987 and 1998. Across this period, the industry was comprehensively deregulated, with many restrictions and regulations lifted or reduced, resulting in vast increases in the hours, places and conditions under which alcohol was available to consumers. The most obvious outcome of this deregulation has been a sharp and sustained increase in the number of alcohol outlets in Victoria. In the twenty years between 1987 and 2006, the number of pubs increased by 34%, the number of packaged liquor outlets more than doubled and the number of licensed restaurants and bars increased eight-fold (Figure 1).

The effects of these increases are the key focus of this thesis. Until recently, the alcohol policy research agenda in Australia has been dominated by studies of trading hours (e.g. 26, 27-35), and there have been few attempts to assess how changes in outlet numbers relate to drinking patterns and alcohol-related harm. This thesis will build on a growing international literature that has examined these issues and will provide a comprehensive assessment of the effects of the changes in alcohol outlet density in Victoria.

1.2. Previous research

The historical background

Places where alcohol is sold have been regarded as potential sources of trouble for many centuries (e.g. 36), and to a greater or lesser degree subject to regulation. One recurrent issue in that history has been the question of density of the alcohol outlets. Social surveyors in the U.S. a century ago, considering what might offer competition to the saloon as the “working man’s club”, drew maps of the downtown areas of American cities documenting the great density of drinking places, in comparison to the paucity of other attractions (37). In the 1890s a British government inquiry, after hearing statistical evidence that there was a causal link between the number of licensed premises in a particular area and convictions for offences of drunkenness, recommended that the number of premises should be reduced systematically (9). Thus, until the late 1990s, the British licensing rules accordingly incorporated community need as a key concern in decisions to grant new licences (9, p. 221). Similarly, as summarised in the previous section, Victorian licensing authorities historically focussed on limiting (or reducing) the number of drinking establishments as a key approach to reducing alcohol problems.

The systems of alcohol licensing and control which were the eventual settlement of the burning disputes of the temperance era accordingly often had provisions limiting the number of one or more types of alcoholic beverage license. In a number of places, the limit was set as a rate per population; thus in California the number of liquor stores allowed in a county is tied to the county’s population (38). In other places, the criterion was one of “need”, to be adjudicated by a magistrate or other authority. These requirements have been stripped away in Victoria in recent years, resulting in the steep rise in licence numbers presented in Figure 1. The issue of the effects of licensing, and in particular of the density and clustering of alcohol sales outlets, has thus come back on the table, as an issue both of policy (e.g. 39) and for research.

This section briefly reviews the research literature that examines the effect of the density of alcohol outlets on levels and patterns of alcohol consumption, and on various indicators of social and health harm. This literature is part of a wider modern literature on the effects of alcohol availability, defined in physical, economic and sometimes also psychological terms

(40-42). Limitations on availability which have been studied include taxation and other price measures (43, 44), restrictions on the minimum drinking age (45), limitations on opening hours and days of sale for alcohol outlets (46, 47), as well as limits on alcohol outlet density (48, 49). The following section provides a broad overview of the theoretical basis for the outlet density literature and a brief summary of the empirical studies that have been published. More detailed reviews of the relevant literatures are then provided in each chapter of the thesis.

Why should outlet density matter?

The examination of the relationship between local-level alcohol availability and health and social outcomes fits into the broader literature on the neighbourhood-level determinants of health. Much of this research has focussed on the impact of neighbourhood level socio-economic disadvantage, although there is a growing literature exploring more specific aspects of the local environment as well. The broad literature focussing on socio-economic disadvantage has found that people living in poor neighbourhoods experience higher rates of an array of health problems, although the literature is particularly compelling for obesity and mental health (50, 51). Studies focussed on more specific environmental factors have, for example, shown that obesity rates are associated with neighbourhood level food availability (52) and that smoking rates are higher in areas with greater tobacco availability (53-57). Similarly, there is an increasingly robust literature linking characteristics of the built environment (e.g. land-use mix, residential density, green-space and exercise facilities) with physical activity and obesity (58, 59).

These neighbourhood-level associations (found while controlling for a wide-range of individual characteristics) have been repeatedly and reliably found in multi-level and ecological studies of health. This has led to much debate over the processes underlying these associations. The treatment of neighbourhood effects as causal contributors to disease and injury rates has been critiqued on both methodological (60) and theoretical grounds (61), although much of this criticism is dependent on the use of strict definitions of causation. Other approaches, such as the treatment of causality as probabilistic, have been more comfortable with the consideration of modifiable risk-factors as causal contributors to rates of disease and injury in the population and thus as crucial areas for scientific study (62). This is the approach broadly taken by observational epidemiologic studies focussing on the role of neighbourhood factors in disease and injury rates – characteristics of neighbourhoods modify

the probability of various outcomes in distinct ways beyond simply those determined by the characteristics of individuals within neighbourhoods.

Glass and McAtee provide a useful conceptual model of understanding the complex causal links between neighbourhood- and individual-level risk factors, individual behaviour and rates of disease and injury (63). Rather than trying to specifically isolate the interactions between neighbourhood characteristics, individual behaviours and health outcomes in a linear stream of causation, they pose neighbourhood factors as ‘risk-regulators’, altering the probability that individuals engage in particular risky behaviours. Thus, in their model for the study of obesity, the cultural norms, deprivation, laws and policies and food environment at the neighbourhood level influence the eating and exercise behaviours of people living in a particular neighbourhood (63, p1662), with the nature and scale of this influence varying based on physiological, behavioural and social characteristics of individuals.

The study of neighbourhood level alcohol availability focuses on a small piece of this broad conceptual framework, examining the links between the built environment (i.e. alcohol outlets) and risky behaviours (e.g. excessive alcohol consumption, violence, drink-driving) either explicitly or via the study of the consequences of those behaviours (e.g. crashes, assault hospitalisations, etc). Thus, in the Glass and McAtee framework, alcohol-outlets function as risk-regulators – increases in the number of alcohol outlets increases the degree to which individuals are exposed to risk related to alcohol consumption, while reductions in outlet numbers decrease their exposure. These risk-regulators will influence risk behaviour differently in different populations and this underpins the use models which examine the interactions between density and other neighbourhood and individual characteristics throughout the rest of this thesis.

While this broad framework provides a general conceptual model for understanding the links between environmental factors and health, researchers studying alcohol availability have gone beyond this broad framework and begun to develop specific theoretical explanations for relationships between alcohol outlet density, drinking and alcohol-related problems. The remainder of this section discusses these specific theoretical explanations in detail.

The theoretical foundations of the variety of associations between alcohol outlet density, alcohol consumption and alcohol-related harm have not yet been fully developed. Many older studies (64, 65) have relied heavily on classic ‘availability theory’, which posits three inter-related propositions: (i) as the availability of alcohol in a community increases, the mean consumption of its population also increases; (ii) as the mean alcohol consumption in a population increases, so the number of heavy drinkers increases; and, (iii) heavy drinking is associated with adverse health and social outcomes, and as the number of heavy drinkers in a population increases, so too does the level of alcohol-related health and social problems (66). There is a wealth of evidence to support the classical postulates of availability theory (42), but in itself the theory does not adequately explain the variable and complex relationships found by studies of the relationship between outlet density and harm.

Stockwell and Gruenewald (67) have expanded the basic propositions of availability theory to take into account variation in how changes in availability may be experienced across drinking groups and the contribution of other factors to rates of harm. Changes in availability are redefined more precisely, in terms of changes in the ‘full price’ of alcohol, including the real price adjusted for the cost of living and convenience in terms of the time and effort required. Thus Stockwell and Gruenewald’s first postulate states 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 costs of obtaining them (67, p217).

In addition, Stockwell and Gruenewald recognize that alcohol-related harms can be affected by changes in availability that do not necessarily alter overall consumption levels. Thus Stockwell and Gruenewald’s second postulate asserts 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) (67, p217).

The mention of “routine activities” in this proposition, a term derived from criminology (68), signals that Stockwell and Gruenewald have moved toward integrating criminological theory

with availability theory. This is indicative of the growing focus of analysts on theories which seek to explain how characteristics of drinkers and their neighbourhoods predispose to criminal activity (e.g. routine activities theory; social disorganisation theory). In criminology, routine activities theory posits that crime takes place when potential offenders and victims come into contact during their day-to-day activities (68). Roncek and Maier (69) and Smith et al. (70) have both suggested that alcohol outlet density is linked to violence through the ability of the outlets to attract large numbers of uninhibited young males, who serve as ready supplies of both motivated offenders and potential victims. Social disorganisation theory, on the other hand, proposes that violence is more likely to take place in communities lacking in collective efficacy or informal social control (71). Alcohol outlets have been suggested as a marker for social disorganisation, as well organised communities may be better equipped than poorly organised ones to resist the addition of outlets to their community through legal and political means (72). In addition, some researchers have suggested that alcohol outlets represent visible signs of neighbourhood decay, effectively announcing that the community cannot collectively respond to problems, thus making it a more attractive area in which to commit crime [33].

Gruenewald has attempted to develop a more rigorous theoretical underpinning for the relationship between alcohol outlet density and violence by focussing on how increasing outlet numbers affect people's drinking choices (73). In his 'assortative drinking theory', increases in outlet numbers provide smaller and smaller niches for drinking premises to fill, resulting in a concentration of violence-prone drinkers in particular outlets, which leads to increases in confrontations and assaults. This provides a potential mechanism for the associations found between bar densities and violence, but has limited explanatory power for outcomes other than assaults. A more specific focus on how availability affects routine *drinking* activities is gradually being developed, with studies examining how changes in specific types of availability affect specific types of harm. This is most clearly demonstrated by Freisthler et al.'s study of child maltreatment, which found on-premise outlet density was linked to rates of child neglect and off-premise outlet density to child abuse, suggesting that outlet density altered where at-risk parents chose to drink, thus affecting the specific nature of the negative outcomes experienced by their children (74).

This brief discussion highlights the difficulty in developing an over-arching theoretical framework that explains the associations between all types of outlets and all kinds of outcomes. Thus, the specific theoretical explanations relevant to the empirical questions tackled in this thesis will be fleshed out within the relevant chapters. Broadly speaking, this thesis will be guided by a combination of routine activities theory and availability theory, with outlet density affecting different drinkers in different ways depending on the type of outlet and the outcome under consideration. Thus, for example, given Melbourne's already high level of alcohol availability, increases in off-premise outlet numbers would be expected to reduce the convenience cost of alcohol purchases by relatively small amounts and would thus be unlikely to greatly affect population level drinking, instead affecting only the drinking of sub-groups of the population for whom access to alcohol is typically more challenging (e.g. young people, very heavy drinkers).

The shape of the research literature: concepts and measures

Alcohol outlet density is generally understood in terms of the number of outlets in a particular area. In the outlet density literature, there have been four methods used to measure this: outlets per capita, outlets per geographical area (e.g. outlets per square mile), outlets per measure of roadway (e.g. outlets per roadway mile) and distance to nearest outlet, with the choice of measure seemingly having little impact on study outcomes (75).

Studying outlet density implies that there is some possibility of this being influenced by factors other than the free operation of the market. Indeed, the studies discussed below have all been carried out in countries in which there has been a tradition of intervention by the state in the market for alcohol, whether by direct state control of some outlets, or by licensing requirements for private sellers. A few of the studies have been carried out in jurisdictions with a history of state-run retail systems (e.g. the Nordic countries other than Denmark, Canada), often in the context of increases in outlet numbers related to privatisation. However, most of the studies have been carried out in parts of the U.S. (notably including California) where all sales outlets are in private hands but licensed by the state. Where the number of licensed outlets changes, factors beyond consumer convenience and rates of alcohol-related harm are likely to be in play. Liquor stores, bars and restaurants are often sources of noise and disturbance, frequently late at night (76), and neighbourhoods may resist any or additional stores being located in their neighbourhood (77). Wealthy neighbourhoods are often better organized to mount such a resistance. The differential resistance may be

crystallized in local ordinances or planning documents which confine bars or liquor stores to less desirable neighbourhoods. The number of licenses of a particular type may be capped by law (as, for instance, in California) (38). Existing licensees, who have an interest in avoiding new competition, may effectively resist new licenses being granted where there is a criterion of "need" in the licensing regulations (12). More generally, the licensing regimes which emerged from the temperance period in all of these countries tended to place limits so that the number of licenses was below what a free market would have produced. But these limits have been relaxed over time, facilitating the expansion of the industry. Because of this, with a couple of notable exceptions, the studies of changes in licensing density have generally been undertaken in periods of increasing alcohol availability.

Outlets are usually grouped into broad categories depending on the nature of their business. The most common approach is to group them into outlets that supply alcohol either for consumption on the premises (e.g. bars, restaurants, taverns) or for consumption off the premises (e.g. liquor stores, grocery stores). However, differences in licensing regimes between study sites have made it difficult to formulate consistent density measures. In some jurisdictions, the clear distinction between on- and off-premise outlets cannot be made, with combined licences allowing outlets to sell alcohol for either on or off-premise consumption (78). In addition, different licensing systems place differing restrictions on the types of alcohol available from certain outlets. In Quebec, for example, beer and wine are available in grocery stores, while spirits are only available at state-owned monopoly retail outlets (79).

Outlet density inherently involves a consideration of units of geography. In the literature, the units used have varied from whole states/provinces down to individual street blocks. The question of what level of unit to use in the analysis has often been largely determined by what is available in the way of data. But this has frequently led to analyses where the spatial units are not very appropriate for the research question. Substantial consideration in undertaking a study should be given to what unit would be most appropriate for a particular research question. In general, smaller geographical units (zip codes or census collection areas rather than cities or states) have proven to be more appropriate for analysing the impact of alcohol outlets, but the most appropriate unit will vary depending on the particular area of interest. For example, for studies focussing on "street" violence, in or near a tavern, the relevant geographical area may be quite small, while for domestic violence or drink-driving

crashes, where the alcohol purchase often occurs at a remove from the casualty, a larger geographical unit may be appropriate.

There is also the related issue of bunching, the grouping of outlets in particularly small areas, to consider. Bunched outlets, particularly on-premise drinking establishments, attract drinkers to a particular location (e.g. a street segment) and the drinkers then 'hop' between premises over the course of a night, following drink specials or other attractions (39). This often results in large numbers of intoxicated people spilling onto footpaths and roads around the bunched premises, increasing the likelihood of problems. There are significant difficulties in disaggregating the effects of bunching from overall alcohol outlet density. For example, very little of the alcohol outlet density literature has focussed on small enough areas to examine the particular effect of bunching (exceptions include (69, 70)), so, while bunching is inextricably linked to outlet density, it is hard to draw conclusions on its specific effects.

A geographic analysis also usually involves issues of contiguity. Events in unit A may be related to events in the next unit, B. Clearly, alcohol bought in one neighbourhood may have adverse effects – a drunken fight or a car crash -- in a nearby neighbourhood. The effects of independent variables across boundaries can be examined using spatially lagged variables in the models developed. A spatially lagged variable is simply an aggregation (generally the mean) of the variable of interest in regions adjacent to the neighbourhood of interest. Thus, for example, Gruenewald et. al. (80) found that the rates of assault in Californian census tracts were related to the number of bars both locally and in neighbouring census tracts. Even when spatially lagged independent variables are incorporated, it is possible that data from spatial units will fail to meet the assumption of unit independence required by standard regression analyses. It is possible that the value of the dependent variable in a region (e.g. the assault rate) will be related to the values of the dependent variable in neighbouring regions, even once all the variables of interest are controlled for. In this sense, data from the two neighbourhoods have an inherent link, analogous to the way that data from 1998 and 1999 have an inherent link in an annual time-series. This lack of dependence has been described and considered in the literature in terms of "spatial autocorrelation", and methods to test and control for it have been utilised. Obviously, the smaller the spatial unit, the more the issue of "spatial autocorrelation" arises, while the larger the spatial unit, the more play there is for possible ecological fallacies (81), where relationships at the level of the spatial units would

misrepresent what is happening at the micro level. Analytical approaches to dealing with these issues are discussed in more detail in Section 2.4 of this thesis.

Previous empirical studies

This section provides a brief overview of the literature that has explored the relationship of alcohol outlet density with alcohol consumption and alcohol-related problems. More detailed reviews of the sub-sections of the literature related to the specific empirical questions tackled in this thesis are provided in the relevant chapters.

Much of the early work in this area explored the relationship between outlet density and rates of alcoholism. Generally, this work was based on broad geographic units such as U.S. states. The studies produced mixed results, with the evidence broadly pointing towards an association between higher rates of alcohol availability and increased rates of alcohol-related harm (although not always with, for example, Colon (82) and Colon and Cutter (83) finding that crash rates were inversely related to rates of on-premise outlets). These state-level studies, while pointing to some plausible effects of outlet density, were limited by the broadness of their geographical units. In a critical review, Smith (19) pointed to methodological weaknesses across the literature, highlighting particularly the reliance on state-level data from the U.S., which introduced substantial confounding. Similarly, Colon (84) drew attention to the differences in availability rates between Bible Belt states in the American South, with many abstainers in the population, and tourist states, suggesting that state-wide outlet density was not the causal variable in the differences in problem rates, which instead reflected the differences in the drinking norms of the states' populations. Thus, while a number of these early studies found significant relationships between numbers of alcohol outlets and rates of drinking and related problems, their fundamental methodological weaknesses mean that their findings cannot be considered particularly robust.

A stronger evidence base on the impacts of increased alcohol availability comes from analyses of the effects of a series of abrupt changes in alcohol control policies, particularly in the Nordic countries (often called 'natural experiments'). This literature has been summarised and updated in English (85). The policy changes studied often resulted in dramatic changes in the number of alcohol outlets. For example, the introduction of beer to grocery stores in Finland increased the number of places alcohol could be bought twenty-fold. This policy change resulted in sharp increases in consumption levels and alcohol-related harm in Finland,

particularly affecting heavier drinkers (86). Similarly, the introduction of medium-strength beer to Swedish grocery stores in 1965 produced substantial increases in total alcohol consumption and alcohol-related harm, which were reversed when this policy change was overturned in 1977 (87). Contrastingly, the introduction of restrictions in parts of Norway greatly reducing the number of places beer could be sold had little impact on overall alcohol consumption (although beverage preferences did change) (86).

The majority of studies of natural experiments in outlet densities outside of Scandinavia have been based on changes in the status of alcohol retail outlets from state-owned monopolies to privately owned retailers. Privatisation of alcohol retail outlets has tended to result in a marked increase in the number of outlets. However, the transition from monopoly retailers to the private sector changes much more than just the number of outlets: reviewing the literature, Her et al. (88) found that privatization also resulted in longer hours, changes to pricing, and an increasingly commercial orientation towards alcohol sales. So, while the majority of these studies have shown increases in alcohol sales following privatisation (79, 88, 89), it is not clear whether these increases relate to the increased number of outlets or to the other concurrent changes. Recent studies in British Columbia have attempted to unpack these effects by analysing small-area data following the partial privatisation of the alcohol retail industry. These studies assessed the effects of the increase in store density following the legislative changes, finding that areas where private store density increased experienced increased per-capita alcohol sales (90) and higher rates of alcohol-related mortality (91). This last study is one of the few studies of changes in alcohol-related problems following privatisation that have been undertaken as opposed to levels of consumption, further limiting the conclusions about outlet density and harms that can be drawn from this work.

A recent legislative change in Geneva, Switzerland preventing alcohol sales in petrol stations and video stores resulted in a sharp reduction in alcohol-related hospitalisations among young drinkers (aged less than 20) (92). However, this policy change occurred concurrently with a sharp reduction in trading hours for off-premise outlets, which is likely to have contributed substantially to the reductions in alcohol-related harm observed (48). Thus it is not possible to determine whether the reduced density of off-premise outlets had a causal role in the reduction in youth hospitalisations.

These natural experiment studies have provided relatively consistent evidence that large change in the number of alcohol outlets influences alcohol consumption and alcohol-related harm. However, the focus of this thesis is on more gradual changes in availability in response to changed licensing regulations. The effects of smaller differences in alcohol outlet density have also been widely studied, usually using data at the neighbourhood or community level rather than the national or state level. Research has thus far found links between alcohol outlet density and:

- consumption and drinking patterns (93-98), particularly among young adults (95, 99-101) and adolescents (102-104),
- assault, homicide and other violent crimes (72, 75, 78, 80, 105-128),
- alcohol-related morbidity and mortality (91, 129, 130)
- drink-driving and traffic accidents (131-142),
- injury (136, 143),
- child abuse and neglect (74, 144-151),
- domestic violence (152-154)
- sexually transmitted diseases (155-158),
- neighbourhood amenity and property damage (121),
- illicit drug use (159), and
- social capital (160, 161).

Along with the Nordic natural experiments (85) and privatisation studies (90) mentioned above, there have been a handful of aggregate studies examining the association between gradual changes in outlet numbers and consumption over time. Longitudinal studies at national (162) and sub-national (163, 164) levels have shown a significant effect of outlet numbers on demand, although the specific results vary. In the UK, Godfrey (162) found that outlet numbers were related to beer consumption (but not wine and spirits), while work in California found the opposite (164). In contrast, a study using data from four Canadian provinces across fifty years found little impact of outlet numbers on consumption, once economic factors were controlled (165). A longitudinal analysis at a smaller geographical level (Californian neighbourhoods) over five years found no relationship between self-reported alcohol consumption and outlet density (166). Cross-sectional studies examining the geographic correlations between alcohol consumption and outlet density have produced similarly mixed findings. For example, Truong and Sturm (98) and Scribner et al. (97) both

found significantly higher drinking in areas with higher alcohol outlet densities, although the specific type of outlets varied, with Truong and Sturm finding significant effects for on-premise outlets, while Scribner et al. found effects for off-premise outlets. In two studies from New Zealand and Australia, outlet densities were associated with episodic heavy drinking but not average consumption levels (93, 167). A study based on data from two U.S. cities added to the mixed evidence in this area, with a significant association between off-premise outlet density and consumption found in New Orleans but not Los Angeles (96). Other studies have found little or no association between outlet densities and self-reported alcohol consumption, highlighting the inconsistencies in this literature (168, 169).

Studies that have focussed on heavy episodic drinking by young adults have produced more consistent findings, although these studies are all cross-sectional and based on college student populations (95, 99-101). There is less consistent evidence for outlet density effects on adolescent drinking, with some studies finding cross-sectional associations (98, 104) while others do not (170-172), particularly when perceived availability is controlled for (173, 174). Two short longitudinal studies have explored how the availability of alcohol in young people's neighbourhoods is related to the initiation and escalation of drinking, with conflicting findings. A study using four waves of survey data from 50 Californian zip codes found that adolescents in areas of high outlet density drank at higher levels in the early waves of the study but that those from areas of lower alcohol outlet density increased their drinking more over the study period, leaving little difference in drinking levels (103). In contrast, a national study with a larger (and younger) sample found that respondents in lower density areas had higher initial levels of consumption, which increased more slowly than that of respondents in high outlet density areas. Thus, while there is consistent cross-sectional evidence that heavy drinking by young adults is associated with alcohol outlet density, there is much less clear evidence that alcohol outlets have a critical role to play in the development of drinking patterns by young people.

The literature linking alcohol outlet densities and alcohol-related problems provides a much more consistent picture than the studies of consumption discussed above. In particular, a growing number of longitudinal studies have found associations between outlet densities and harms over time. A national study from Sweden using thirty-five years of data found that changes in the number of on-premise outlets were associated with changes in police records

of violence (110). More recent analyses have used cross-sectional time-series approaches, with a large number of geographical units analysed across shorter time periods. For example, Gruenewald et al. (122) used data from 581 Californian zip codes across six years, finding that both off-premise outlet and bar densities were associated with assault rates over time. Also in California, similar approaches have found longitudinal relationships between alcohol outlet density and child maltreatment (175), intimate partner violence (152) and traffic accidents (176) using small area data. A study using a broader geographical basis and larger spatial units found significant correlations over time between outlet densities and youth homicide rates in the 91 largest U.S. cities (128). Another series of studies from California made use of the sharp reduction in alcohol outlets that occurred in Los Angeles following the 1992 civil unrest during which many liquor stores were destroyed and, following community pressure, not re-opened. Using this natural experiment, Yu et al. (123) found that assault rates fell significantly in Census tracts where outlet licences had been surrendered. Two studies using the same natural experiment provided longitudinal evidence that alcohol outlet densities are related to other alcohol-related outcomes, with gonorrhoea rates falling sharply in areas where off-premise outlets had closed down (157) and voting rates increasing (160).

A large number of cross-sectional studies support these findings, particularly relating to assault and other violent crimes. Dozens of cross-sectional ecological studies have demonstrated that problem rates are higher in areas with higher levels of alcohol outlet density, although there is substantial variation between studies in terms of the types of outlets identified as problematic and the interactions between outlets and other neighbourhood factors. A number of reviews of this literature have recently been published – see Livingston et al. (177), Popova et al. (48) and Campbell et al. (49) for more details.

Thus, the literature provides mixed evidence that small variations in alcohol outlet density (across time or space) affect levels of alcohol consumption, with the most reliable evidence pointing towards small effects on episodic drinking amongst young adults. In contrast, there is reasonably consistent evidence that alcohol-related problems, particularly violence, are affected by the density of alcohol outlets¹. The literature is limited in a number of general ways: it is largely from North America (and even then, largely from one U.S. state,

¹ Some potential explanations for the more reliable findings in studies of harm than in studies of consumption are discussed in more depth in Chapter 7.

California) and is dominated by correlational cross-sectional studies. These limitations will be addressed across the remainder of this thesis, along with the a number of more specific gaps in the research evidence which are outlined briefly in the final section of this chapter.

The relationship between alcohol outlet density and socio-economic inequality

Socio-economic disparities in health outcomes have become a key focus of public-health research and policy (178), with a range of studies demonstrating poorer health among disadvantaged people and examining potential mechanisms for these inequalities (see 179 for a review). As discussed earlier, the distribution of alcohol outlets in a community is not likely to be driven entirely by a free market response to patterns of demand. Alcohol outlets in most societies are subject to substantial regulation, and certain communities may be better placed to use the regulatory structures to limit their exposure to the noise, litter and other issues associated with certain licensed premises. The distribution of alcohol outlets is of substantial public health interest given the potential for health inequalities to be affected by alcohol consumption. A number of studies in other areas of public health have linked inequalities in local environment with inequalities in health outcomes. For example, researchers trying to explain the substantial social gradients in smoking rates or obesity have demonstrated that people living in poorer communities are exposed at much higher rates to tobacco retailers (53, 55, 180) and fast food outlets (181-183) than those in areas of socio-economic advantage.

Alcohol is a little more complicated than tobacco or obesity, in that there is no consistent social gradient in measures of alcohol consumption (184-187, 188, p. 37). However, given the generally consistent relationship between alcohol-related harm and socio-economic disadvantage (185), a growing number of researchers have explored the socio-economic distribution of alcohol outlets, generally finding that outlets are concentrated in poor neighbourhoods. Early researchers in this area suggested that these disparities reflected differences in drinking customs across the social classes (189). However, increasingly researchers have pointed to structural factors related to issues such as zoning that have made it possible for wealthy neighbourhoods to resist the encroachment of potentially problematic venues (77). Thus, recent studies have focussed on the inequalities represented by the distribution of outlets rather than assuming that it reflects the tastes of residents. For example,

Gorman and Speer used data from a single city in New Jersey to examine inequalities in exposure to alcohol outlets (190). They found that alcohol outlets were generally concentrated in more disadvantaged neighbourhoods, although the area with the highest number of outlets had a low level of poverty. LaVeist and Wallace (191) conducted a similar analysis using data from Baltimore focussing only on takeaway liquor stores. As with the New Jersey study, they found substantially higher densities of liquor stores in poor, black neighbourhoods. Similarly, Truong and Sturm (102) using data from across California and Bluthenthal et al. (192) using data from Los Angeles and Louisiana found that alcohol outlet numbers were higher in neighbourhoods with low incomes and high minority populations. Nielsen et al. (193) used data from San Diego to develop more sophisticated models of the relationship between social class and alcohol availability, incorporating a range of control variables. This produced less clear associations with minority populations than previous U.S. research, but similarly strong relationships between socio-economic disadvantage, residential instability and off-premise alcohol outlet numbers. Thus, there are relatively consistent findings across a number of studies of sub-areas of the U.S., with alcohol outlets generally found at higher rates in socio-economically disadvantaged areas.

Two more recent studies examined these relationships across the whole of the U.S. (194, 195), confirming that in urban areas poor communities face much higher exposure to liquor stores than advantaged communities. Romley et al. (195) focussed on urban areas of the U.S., finding that liquor stores in particular clustered in poor, black neighbourhoods, but that bars were also more concentrated in low income areas. This was supported by more recent work by Berke et al. (194), who used data from regional and rural areas as well as cities across the U.S. Their results suggested that the relationship between poverty and alcohol availability is strongest in urban areas and much less notable in suburban or regional parts of the U.S. Outside of the U.S., two national studies in New Zealand (196, 197) identified similar patterns, with bars, clubs and takeaway liquor outlets all substantially more likely to be located in more deprived neighbourhoods, while a study in Glasgow produced much less clear results (198). It is worth noting that these studies use a range of methodologies and measures. For example, Hay et al. (197) measured the mean distance to the nearest outlet, while Romley et al. (195) use density per capita and per 100 roadway miles.

This growing literature, predominantly from the U.S., points to a substantial social gradient in exposure to alcohol outlets, with poor and minority neighbourhoods experiencing much higher alcohol outlet densities than richer, white neighbourhoods. While the results have been relatively consistent, there remains significant work to do in this area. Few of these previous studies have incorporated socio-demographic controls, with only Nielsen et al. incorporating a range of control variables (193), while none of these studies attempted to control for measures of non-resident neighbourhood usage (e.g. tourism). Thus far there have been only three studies outside the U.S. (two from New Zealand and one from Scotland) which, given the variety of regulatory regimes between (and within) countries, suggests it is too early to assume a general pattern exists. Furthermore, there have been no attempts to examine how the distribution of alcohol outlets varies over time or in response to regulatory changes, which are key questions for the development of more equitable alcohol policies.

1.3. Thesis outline

The remainder of this thesis will present a series of empirical studies exploring the impacts of the sharp increases in the number of alcohol outlets in Victoria in recent years on alcohol consumption and related harm. The empirical studies make up the first comprehensive Australian attempt to tackle these issues, building on a handful of previous studies in New South Wales (121, 199) and Western Australia (200). In addition, it will fill a number of key gaps in the broader research literature. These are presented below along with an outline of the thesis. While brief chapters on methods (Chapter 2) and conclusions (Chapter 9) will be included, each empirical chapter will include detailed discussion of the relevant literature, the specific methods used and the implications of the findings.

- Chapter 2 will summarise the common data and methodological approaches used across the empirical studies in Chapters 3 to 8.
- Chapter 3 will provide a systematic examination of trends in alcohol consumption and alcohol-related problems in Victoria during this period of liberalisation, drawing together disparate sources of data to provide a broad view of how drinking and drinking problems have changed in the last fifteen years. This chapter draws on two previously published papers on Victorian trends focussing on the whole population and on young people specifically:

Livingston M. Recent trends in risky alcohol consumption and related harm among young people in Victoria, Australia. *Australian and New Zealand Journal of Public Health*. 2008;32(3):266-71.

Livingston M, Matthews S, Barratt MJ, Lloyd B, Room R. Diverging trends in alcohol consumption and alcohol-related harm in Victoria. *Australian and New Zealand Journal of Public Health*. 2010;34(4):368-73.

The work of these papers is extended in this chapter in two ways: the findings of the two papers are integrated and discussed, and some more detailed analyses of mortality data are presented.

- Chapter 4 examines the cross-sectional relationship between alcohol outlet density and very heavy drinking by young adults (aged 16-24) in Victoria. This study extends previous studies in this area in two ways: firstly, it uses a general population sample rather than one based on college students and secondly, it uses a higher than usual cut-off for heavy drinking, representing behaviour much more likely to be associated with significant harms. This chapter is based on:

Livingston M, Laslett AM, Dietze P. Individual and community correlates of young people's high-risk drinking in Victoria, Australia. *Drug and Alcohol Dependence*. 2008;98(3):241-8.

- Chapter 5 incorporates a systematic analysis of the local level relationship between alcohol and violence in Melbourne both at a single point in time and longitudinally. These studies provide much-needed non-US evidence on the link between outlet density and violence, including a rare longitudinal analysis of the association. In addition, this chapter provides rigorous approach to specifying the nature of the relationship between density and violence, including whether density effects on violence are linear or non-linear and whether alcohol outlets have different associations with violence in different types of neighbourhood. This chapter draws on two published papers focussing separately on the cross-sectional and longitudinal relationships:

Livingston M. Alcohol outlet density and assault: a spatial analysis. *Addiction*. 2008;103(4):619-28.

Livingston M. A longitudinal analysis of alcohol outlet density and assault. *Alcoholism: Clinical and Experimental Research*. 2008;32(6):1074-9.

- Chapter 6 builds on the scant literature that has examined how alcohol outlet density relates to domestic violence (152-154). This chapter is drawn from a published paper,

examining the longitudinal relationships between density and domestic violence, which is extended via the examination of the relationship between outlet density and domestic violence in different neighbourhood types:

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

- Chapter 7 tests the routine drinking activities theory proposed by Freisthler et al. (74) by examining the relationship between chronic and acute alcohol-related hospital admissions and different types of alcohol outlets longitudinally. This chapter also provides the first small-area longitudinal analysis of the relationship between alcohol outlet density and chronic disease. This chapter is based on a previously published paper:

Livingston M. Alcohol outlet density and harm: comparing the impacts on violence and chronic harms. *Drug and Alcohol Review*. 2011;30(5):515-23.

- Chapter 8 provides the first Australian examination of the socio-economic distribution of alcohol outlets and the first attempt internationally to examine how this distribution changes during a period of liquor liberalisation. This chapter is made up of unpublished longitudinal analyses and a cross-sectional paper that has been accepted for publication:

Livingston M. The social gradient of alcohol availability in Victoria, Australia. *Australian and New Zealand Journal of Public Health*. In press.

- Chapter 9 summarises the findings of the empirical studies and discusses their implications for public health research and for liquor licensing policy both locally and internationally.

Chapter 2. Data and methods

Each of the subsequent empirical chapters will contain detailed explanations of the specific data and methods that are used within them. This section is thus intended to provide only a broad overview of the methods used in this thesis, focussing on the overarching methodological approach and on the data and analytical considerations that are repeated across a number of chapters. In particular, this section will briefly examine the spatial units used in the small area analyses, discuss the liquor licensing data used to derive measures of outlet density throughout the rest of this thesis, and summarise the key analytical issue of spatial autocorrelation that recurs across most of the ensuing analyses.

2.1 *Broad methodological approach*

This thesis is made up of quantitative analyses of a range of secondary data sources. Administrative and survey data were provided by a number of government and research organisations and were accessed according to the relevant organisational protocols. The project received ethical approval by the University of Melbourne Human Research Ethics Committee (ref: 0931176.1) and relevant data approvals were given by the Victorian Department of Health², the Victorian Police Service and the Australian Social Science Data Archive.

The analytical approach undertaken in this thesis is quantitative, with a broadly ecological framework. This approach has inherent weaknesses; in particular, using aggregated, quantitative data smoothes over the rich variety of human interactions that make up the incidents represented in the data used here. Thus, for example, the records of police incidents grouped together here as ‘alcohol-related assaults’ are likely to represent diverse and complex events, which are necessarily simplified for quantitative analyses. Similarly, the analysis of secondary administrative data reduces the researcher’s ability to fully understand what the data being used represents. Data used here are often not collected for research purposes (e.g. police and hospital records) and are likely to be in part driven by the administrative requirements of the organisations collecting them. Despite these weaknesses (which are discussed in detail in the final chapter of the thesis), the approach taken provides a robust and

² Previously the Victorian Department of Human Services

relatively objective approach to assessing the impact of large-scale changes in alcohol availability on rates of alcohol-related problems. The impacts of the changes to alcohol availability studied here are likely to be small and gradual at the individual level, requiring the use of quantitative analytical approaches capable of detecting distinct relationships at the population level. While the problems of using administrative data for research purposes have been widely acknowledged (e.g. 201), these sources of data represent the best source of knowledge on rates and trends in alcohol-related problems available at a population level, and their use has a long history in social science and public health research.

2.2 Spatial units

The small-area studies in this thesis focus on the Greater Melbourne area, approximately 5,600 square kilometres containing the city of Melbourne, the second largest city in Australia, and its surrounding suburbs. The studies were undertaken using postcodes as the unit of analysis. These regions are an administrative unit defined by Australia Post, and represent the smallest geographical units for which reliable data were available for all the variables required for the analyses undertaken³. At the time of the 2001 Census (the approximate mid-point of the period studied in this thesis), there were 223 postcodes and approximately 3,350,000 residents. The longitudinal studies made use of 186 postcodes across Melbourne that had consistent boundaries over the study period, incorporating approximately 85% of the population of Melbourne. On average, postcodes in greater Melbourne have an area of 14.7km². This is roughly half the size of the U.S. zip codes and four times the size of Census Tracts commonly used in similar studies. There has been little systematic attempt to assess whether the scale of the geographic unit of analysis has an impact on the estimates of the effect of alcohol outlet density in spatial studies. Early studies that used entire cities as their geographic units resulted in null findings, which were later shown to be artefacts of this large geographic scale (108, 109). However, studies that have used zip codes (80, 122), census tracts (145, 160) or census block groups (150, 202) have subsequently produced similar findings, and the one analysis to directly examine the impact of spatial scale found little effect (109). Thus, while the use of postcode across this thesis is a matter of data availability,

³ Note that Census Collection District data is used in Chapter 8. This is because the analyses are based only on liquor licensing and Census data, which are both available at this more detailed level.

these units fit within those used in the remainder of the literature and are unlikely to result in biased estimates.

Postcodes generally represent local suburbs or communities, although some in the outer areas of the city encompass much larger non-residential areas including state parks or large industrial zones. Geographical data relating to postcodes (e.g. area, neighbouring postcodes) were extracted from the digital boundaries released by the Australian Bureau of Statistics (ABS) as part of the Australian Standard Geographical Classification (ASGC) (203). Two postcodes that represented particularly unusual land uses and low residential populations (i.e. an airport and a military base) were excluded from all analyses. A map of the study area is provided in Figure 2. Descriptive data describing the demography, alcohol availability and alcohol-related problem rates for the study postcodes are provided where relevant in each of the subsequent thesis chapters.



Figure 2 – Postcodes within the Greater Melbourne Statistical Division, based on 2001 ASGC boundaries

2.3 *Liquor licensing data*

The analyses presented in this thesis focus on the contribution of three types of alcohol outlet (general, packaged and on-premise, defined in detail below) to a range of alcohol-related problems from 1991 to 2007, with specific study durations varying depending on data availability. A number of licensing categories have been excluded from this study – these include vigneron (wineries), pre-retail (wholesalers), limited (single event or limited retail) and club (sporting and other membership-based venues) licences. The first three of these categories were excluded due to their lack of relevance to the outcomes under study here – it is unlikely that changes to the number of wineries or wholesalers in an area would impact on the population’s drinking choices, while limited licences generally apply to one-off events or

very specialised outlets (e.g. bed and breakfasts supplying to their patrons). Clubs represent a more widely used type of liquor outlet in Victoria, but due to changes in licensing definitions across the study period it was not possible to include a consistent measure of club licences in the current studies.

The three licence categories used in this study are the three major suppliers of alcohol in Victoria. In 1996, the last year for which detailed sales data were available, 94.5% of all alcohol sold in Victoria was sold from these three licence types (see Table 1 below). While the amount of alcohol sold by on-premise outlets was relatively small in 1996, this is likely to have increased substantially over the study period, as the number of these licences grew dramatically, making their inclusion in the study necessary. In terms of raw numbers, these three licence categories made up 70% of the licences in Victoria over the study period (excluding limited licences).

Table 1 - Distribution of alcohol sales by licence type in Victoria, 1996 (source: Liquor Licensing Commission Victoria 1996/97 Annual Report)

Licence type	Proportion of sales
General (on-premise and packaged sales)	39.6%
Packaged liquor	48.4%
On-premise	6.6%
Club	3.6%
Producer/Distributor (including vigneron)	0.7%
Limited	1.1%

General liquor licences are the licence category used by hotels (pubs) in Victoria. Historically, these have been the dominant licence type in the state (see Figure 1) and provide the licensee with the ability to sell alcohol for both on- and off-premise consumption. No recent data are available to estimate what proportion of alcohol general licences sell for off-premise, but it is likely to have declined sharply with the rise of the large supermarket-run packaged liquor outlets. While some outlets with general licences provide food, the major focus of these outlets tends to be on the consumption of alcohol. Packaged liquor licences are provided to outlets selling alcohol only for off-premise consumption. In Victoria, this basically includes bottle-shops and supermarkets, with a number of other types of outlet specifically barred from selling alcohol (e.g. convenience stores, petrol stations, video shops). Finally, on-premise licences are provided to outlets licensed to sell alcohol only for on-

premise consumption. This broad category includes cafes and restaurants as well as some bars and nightclubs (although late-trading nightclubs have often preferred general licences). The majority of outlets in this category are restaurants, although specific data on the distribution of on-premise outlet types is not available across the study period.

Data on active liquor licences were provided by Responsible Alcohol Victoria⁴ (and historically by the licensing branch of Victorian Department of Consumer Affairs). Licensing data included all active licences as at the 30th of June for each year (i.e. licence counts for 2005 are based on licences active on 30/6/2005). The licensing data include postcode information for each premise and this field was used to assign outlets to postcodes. A check on the addresses of 500 random records found that the postcode data was accurate in 98% of cases. Data on trading hours, venue capacity or alcohol sales were not available, so the effects of specific characteristics of outlets, beyond licence type, will not be examined in this thesis. This represents one of the key limitations of the work presented here – each outlet of a particular type is treated as equivalent. In other words, a grocery store with a small alcohol section and a warehouse sized liquor store are both counted as one packaged licence. Similarly, a corner pub with a capacity of 100 and a multi-story venue with a capacity of thousands are both treated as single general licences. In future, improved data on venue size and/or alcohol sales are required to develop more nuanced understandings of the contribution of alcohol outlets to a range of health and social problems.

The other specific data sources used in this thesis will be described in the relevant chapters.

2.4 Spatial modelling

The majority of the studies included in this thesis are based on the analysis of postcode-level data. Spatial data analysis presents some specific issues that need to be addressed. In particular the core assumption of ordinary least squares regression, that the data under analysis are independent, is likely to be breached when using spatial units of analysis. As Gruenewald et al. (166) lay out, unmeasured factors affecting outcomes in one area are likely to have similar impacts on neighbouring areas, creating correlations between nearby units.

⁴ Responsible Alcohol Victoria is the government agency responsible for managing the liquor licensing system in Victoria, taking the place of the licensing branch of Consumer Affairs in 2008

This spatial autocorrelation can result in biased model results, with positive spatial correlation (i.e. the situation where nearby units are more similar to each other than to units further away) leading to increased likelihood of Type 1 errors.

Thus, studies based on spatial data need to test for and, where necessary, control for its effects. This is basically done by incorporating the spatial structure of the data into the modelling process, either by modelling it explicitly or by testing for spatial correlations in the model residuals. To enable this, the spatial structure must be specified. In other words, a matrix must be developed explicitly stating how spatial units are related to each other. While there are a variety of weighting schemes used to do this (e.g. based on distance between units), the studies in this thesis make use of the simplest approach: contiguity weights. In this instance, spatial correlations between units directly neighbouring each other are tested and modelled. As no account is taken of non-neighbouring units, this approach does not deal with spatial correlations at greater distances, however it is the standard approach used in the public health field and has proven sufficient to deal with the kinds of biases detected in models of the type presented here (80). The explicit derivation of the models used has been provided elsewhere (166, 204, 205). The specific modelling approaches taken in each case will be described within the following empirical chapters, but this discussion of the means of dealing with the spatial structure of the data will not be repeated.

Chapter 3. Broad trends in alcohol consumption and related problems in Victoria⁵

3.1 Introduction

The overarching aim of this thesis is to estimate the impacts on alcohol consumption and related problems of the substantial increases in the number of alcohol outlets in Victoria since the late 1980s. As a first step in this process, this chapter examines broad trends in measures of alcohol consumption and harm over recent years to assess how they relate to the dramatic increases in outlet numbers (see Figure 1) in the same period.

Much of the recent attention to alcohol problems in Australia has been driven by perceptions that these problems are increasing. For example, the former Australian Prime Minister, Kevin Rudd, discussed an ‘epidemic of binge-drinking’ and described alcohol problems as ‘getting out of control’ (206), suggesting dramatic recent changes in drinking harm. This has been reinforced by media coverage suggesting that alcohol-related problems are becoming increasingly common (206-210). Despite the widespread reporting of worsening problems, little recent systematic work has been undertaken to assess the trends in alcohol consumption and related problems either nationally or in Victoria. Thus, this chapter examines recent trends in measures of alcohol consumption and related harm in Victoria, both for the whole population and specifically among young people.

There has been some previous work in this area, largely through the National Alcohol Indicators Project (NAIP), which provides estimates of national and state trends in consumption and harm in a series of bulletins and reports (e.g. 211, 212). The most recent report (213) finds an increase of almost 80% in alcohol-related hospitalisations in Victoria between 1996 and 2005, and almost no change in alcohol-related deaths over the same period.

⁵ This chapter is based on work from two publications:

Livingston, M., Recent trends in risky alcohol consumption and related harm among young people in Victoria, Australia. *Australian and New Zealand Journal of Public Health*, 2008. 32(3):266-271

Livingston, M., S. Matthews, M. Barratt, B. Lloyd, and R. Room, Diverging trends in alcohol consumption and alcohol-related harm in Victoria. *Australian and New Zealand Journal of Public Health*, 2010. 34(4):368-373.

There have been two recent studies that have explored trends in alcohol consumption and related harms amongst young people in Australia (214, 215). Clemens et al. (215) examined trends at the national level in data from the National Health Survey and the National Drug Strategy Household Survey, with only a small section exploring the results specifically for youth consumption. Their results highlighted the discontinuities in methodologies between survey waves and, when direct comparisons were available, found little change in youth risky drinking over recent years (215, p.48). Chikritzhs et al. (214) focussed on indicators of alcohol-related harm based on aggregated estimates of alcohol-attributable hospitalisations and deaths. In their Victorian data, trends in these indicators were either stable (for hospitalisations) or decreasing (for deaths). However, these indicators do not strictly measure alcohol-caused harms and it is possible that trends in these kinds of injuries will be influenced by factors unrelated to alcohol. Much of the data underlying these indicators are based on conditions that are partially attributable to alcohol. Thus, for example, a fixed proportion of assault-related hospitalisations are treated as ‘alcohol-related’ over the study period, meaning that any increase (or decrease) in assaults will be treated as an increase (decrease) in alcohol-related assaults (216). Thus, the use of measures based on alcohol-attributable fractions in assessing trends in alcohol-related harm over time needs to be supplemented with a range of alcohol-specific measures.

This chapter will examine trends across a broader range of measures, firstly for the total Victorian population and then for young people. Methods and results will be presented separately for the whole population and then the youth-specific analyses, with the discussion section incorporating the findings of both.

3.2 Methods

The measures for this analysis were selected based on the indicators outlined in a WHO guide to monitoring trends in alcohol consumption and harm (217). This guide suggests that the risks of identifying spurious trends can be minimised by making use of a variety of different indicators and by including some indicators with direct alcohol attribution (e.g. emergency department presentations for alcohol intoxication) as well as indicators based on proxy measures of alcohol involvement (e.g. single-vehicle night-time road crashes). The specific indicators were selected to cover a broad range of harms, including those related to acute

problems (e.g. night-time assaults, emergency presentations for alcohol intoxication) and those related to chronic alcohol consumption (e.g. alcohol-related mortality and morbidity).

Alcohol-related harms

This section summarises trends in eight indicators of alcohol-related harm for the entire population of Victoria. Harms are presented as rates per 10,000 residents in Victoria (based on Estimated Residential Populations produced by the Australian Bureau of Statistics). Harm trends are examined for financial years beginning July 1 from 1999/00 through to 2007/08 unless otherwise noted. The indicators used include measures based on proxies of alcohol involvement (e.g. single vehicle night-time motor vehicle crashes), unambiguous direct alcohol measures (e.g. emergency department presentations for alcohol intoxication) and measures based on some combination of the two (e.g. alcohol-related hospital admissions). Due to limitations in data availability (e.g. police data) or low prevalence rates (e.g. traffic accidents and deaths), trends amongst young people are examined for just the hospitalisation and emergency presentation measures. Population rates have all been based on Estimated Residential Population figures produced by the Australian Bureau of Statistics (218).

Alcohol-related hospitalisations

These data are based on all hospital separations (including both private and public hospitals) in Victoria as collated in the Victorian Admitted Episode Database (VAED) (219). Hospital separations related to alcohol have been extracted from all separations based on the ICD-10 codes of the principal diagnosis associated with the separation. This extraction was based on alcohol-attributable fractions derived from previous reviews of the literature by English et al. (220) and Ridolfo and Stevenson (221). Thus, the alcohol-related hospital admissions reported here include both alcohol-specific diagnoses (e.g. alcoholic liver cirrhosis, alcohol intoxication, etc.) and proportions of other diagnoses to which alcohol contributes (e.g. motor vehicle crashes, stroke, some cancers, etc.). The majority of alcohol-attributable hospitalisations experienced by young people are likely to be injury-related. The use of trends in these measures to assess trends in alcohol-related harm has been critiqued by injury researchers (216) and thus the hospitalisation measure used in the youth analysis will include only wholly alcohol-caused hospitalisations (e.g. alcohol intoxication, alcohol poisoning, alcoholic liver cirrhosis etc).

Alcohol-related mortality

These data are based on the Unit Record Mortality data collected by the Australian Bureau of Statistics. Deaths are attributed to alcohol based on the primary cause of death using the same method of attributable fractions described for hospitalisations. Mortality data are based on calendar year rather than financial year.

Emergency department presentations for intoxication

These data have been extracted from the Victorian Emergency Minimum Dataset (VEMD), which includes data from all emergency data presentations in Victoria. Full details of the dataset are presented in a user manual (222). All presentations with an ICD-10 diagnosis code of F10.0 (acute intoxication due to alcohol) were extracted.

Alcohol-related ambulance attendances

Data from all alcohol- and drug-related ambulance attendances in greater Melbourne are collected as part of a broader surveillance project. These data include paramedic assessment of specific alcohol and drug involvement for all ambulance attendances, and data have been extracted for this study where paramedics have reported alcohol consumption by the patient. Due to industrial action, the ambulance attendance dataset is missing data from June 1999, May to July 2001 and June and July 2004. Data for these missing months have been interpolated based on data from the preceding and subsequent years.

Alcohol-related assaults

The data are based on police records of assault incidents recorded in Victoria Police's incident database (the Law Enforcement Assistance Program, or LEAP). As there is no reliable coding for alcohol involvement in these offences, assaults from Friday and Saturday nights (between 8pm and 6am) have been used as a proxy for alcohol-related assaults. Data from a previous Victorian study (223) suggest that around two-thirds of assaults during these periods are alcohol-related.

Alcohol-related domestic violence

These data have been provided by Victoria Police from their LEAP database. Data on 'family incidents' (predominantly incidents of domestic violence) are recorded by the investigating officer, with a specific field for alcohol involvement in the incident. While this recording of alcohol involvement is subjective, it provides a contrast to the data for general

assault, where alcohol involvement is estimated based on the time of day and day of the week of the incident. Family incidents where alcohol involvement was considered ‘possible’ or ‘definite’ (around 41% of all family incidents in 2006/07) were included as alcohol-related in this study.

Courses of treatment for alcohol

Data on courses of alcohol treatment in Victoria are stored in the Alcohol and Drug Information System (ADIS), which collates information from all community-based specialist drug and alcohol treatment services in Victoria. The annual number of courses of treatment where the primary drug of concern was alcohol was extracted from ADIS to provide an estimate of trends in treatment utilisation for alcohol problems in Victoria.

Single-vehicle night-time motor vehicle crashes

Single-vehicle night-time crashes are widely used as a proxy measure of alcohol-related motor vehicle crashes (217). In Victoria, data on all motor vehicle accidents resulting in either fatalities or hospital emergency department presentation are collected by police and provided to VicRoads for entry into their Road Network Database, which includes information on the number of vehicles involved in the accident and the time of day and day of the week of the accident. Based on previous research in Victoria, slightly different hours are used to assign crashes as ‘night-time’ for rural and metropolitan areas and between weekends and weekdays (223). Crashes occurring within the times identified as high alcohol times and involving only one vehicle were extracted for this study as a proxy for alcohol-related crashes.

Trends in these harm indicators were tested for statistical significance using the ratio of the rate of each indicator in the most recent year to the rate in the earliest year for which data was available. Confidence intervals were calculated using the incidence rate-ratio calculator in Stata 11.0 (224).

Survey estimates of risky drinking

Measures of risky alcohol consumption derived from three different sets of surveys are examined in this section. Survey data from the five studies (including two youth specific surveys) cover 2000 through to 2009 (with varying coverage by study). Due to the difficulties in comparing results from different studies, survey results are only compared

within waves of the same study and not across studies. Most survey data have been taken from published reports, with only the most recent report cited in full for the sake of brevity. Some of the youth-specific data from the National Drug Strategy Household Survey and the Victorian Youth Alcohol and Drug Survey have been extracted from the unit record data files. Standard errors for survey estimates are not reproduced here, but the statistical significance of any differences observed over time is discussed. Estimates of risky drinking are all based on the 2001 NHMRC drinking guidelines (225), and separate estimates for short- and long-term risk are presented. Male respondents were classified as short-term risky drinkers if they drank in excess of six drinks in a day, twelve or more times a year. The cut-off for females was lower – more than four drinks in a day, twelve or more times a year⁶. For long-term risk, male respondents are classified as risky drinkers if they drink an average of more than four drinks per day, while for females the cut-off is more than two drinks per day. Only short-term risky drinking prevalence is presented for the youth analyses.

The National Drug Strategy Household Survey

Data from the National Drug Strategy Household Survey (NDSHS) were available for 2001, 2004 and 2007 (188). The NDSHS is a national mixed-methods survey (using both drop-and-collect and telephone interviews for data collection) that has asked consistent questions on alcohol consumption across the three waves under consideration here. Response rates for the NDSHS across the three waves were low but comparable (47%, 46% and 49%), and the Victorian sample size for each wave was sufficiently large for reliable estimates (between 4,800 and 6,300). Data on alcohol consumption were collected using the graduated frequency method (226), which asks respondents to report how often they drank at various levels in the past 12 months. Risky drinking rates from the NDSHS are for Victorians aged 14 and over. Separate analyses for the youth populations were undertaken using the NDSHS. Comparable data were only available for the two older youth age groups in 2001, as that year's sample did not include anyone younger than 14. Sample sizes for the youth analyses were approximately 700 in each wave.

⁶ Due to the structure of the questionnaire, short-term risky drinking in the Australian Secondary Students Alcohol and Drug survey was based on one risky drinking episode in the last week rather than at least twelve over the last year.

The Victorian Population Health Survey

Data from the Victorian Population Health Survey (VPHS) were available from 2001 to 2008 (227). The VPHS has used consistent alcohol questions from 2002 to 2008, using simple usual drinking frequency and usual drinking quantity to measure total volume of consumption, and then asking a specific question about how often respondents drank in excess of the 2001 NHMRC guidelines. In 2001 this question on drinking pattern was not included, so only long-term risky drinking can be assessed using the 2001 data. Across the eight waves, the participation rate of the VPHS has been reasonably high and consistent (between 61% and 69%) and the sample has been 7,500 every year. The VPHS includes only respondents aged 18 or over, so risky drinking rates for this survey are for adult Victorians. Data from this survey are used to provide estimates of risky drinking for 18-24 year olds in the youth-specific section of this chapter.

The National Health Survey

Data from the National Health Survey (NHS) were available for 2001, 2004/05 and 2007/08 (228). The NHS has used consistent alcohol questions across the three waves of data collection, based on three-day recent recall diaries of alcohol consumption. The nature of these questions means that only long-term risky drinking is reported for the NHS. Across the three waves examined, the NHS had had a consistent and excellent response rate (92%, 89% and 91%) and a Victorian sample in excess of 3,000. Alcohol questions were only asked of respondents aged 18 or over, so risky drinking rates for this survey are for adult Victorians. Because only long-term risky drinking can be measured using the NHS, it wasn't included in the youth-specific analyses.

The Australian Secondary Students Alcohol and Drug Survey

The Australian Secondary Students Alcohol and Drug surveys (ASSAD) are undertaken every three years and data from 2002 to 2008 (3 waves) are presented here. School-level response rates were around 70% (although response rates for all waves of the ASSAD surveys were not available). Data for the ASSAD surveys comes from interviews with a multi-stage random sample of secondary students across Australia (aged between 12 and 17), and is undertaken in the classroom. Victorian high-school retention rates have been stable over the three waves being examined here, so comparable populations are being compared (229, p.5). The alcohol measures for this survey were derived from a retrospective weekly

diary of the respondent's drinking. Thus, risky drinking measures for this study are only measured within the week prior to the survey. All risky drinking data on the ASSAD surveys have been compiled from published reports (e.g. 229). Data are available from the ASSAD for 12-15 and 16-17 year olds.

The Victorian Youth Alcohol and Drug Survey

The Victorian Youth Alcohol and Drugs Survey (VYADS) is a telephone survey that focuses only on people aged between 16 and 24 and collects large Victorian samples. The VYADS has been undertaken four times: each year from 2002-2004 and then again in 2009. Response rates for the VYADS surveys have not been published, although each wave has reported cooperation rates of around 70% (230). The alcohol measures are collected using the standard graduated quantity-frequency questions and have remained unchanged across the four survey waves. Data from VYADS are used to provide risky drinking prevalence estimates for 16-17 and 18-24 year olds.

3.3 Results for the total population

Alcohol-related harm

Trends in the eight harm indicators are presented in Table 2, along with rate ratios of the rates in the last and first year of data available. Thus, for example, the rate of hospitalisations in 2007/08 was 1.47 times larger than the rate in 1999/00. Six of these indicators have seen statistically significant increases over the time-period examined, while single-vehicle night-time motor vehicle crashes and alcohol-related mortality have remained relatively stable (with mortality rates declining slightly). The largest increase has been in alcohol-related ambulance attendances, which have increased by 169% over the last nine years. Emergency presentations for intoxication have almost doubled, increasing by 98%, while night-time assaults, domestic violence, hospitalisations and treatment episodes have all increased more slowly, but have still grown significantly (49% for assaults, 42% for domestic violence, 47% for hospitalisations and 55% for treatment episodes).

Table 2 - Trends in the rates (per 10,000) of alcohol-related harm in Victoria, 1999/00 to 2007/08⁷

Harm type	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	Rate ratio (last year/ first year)	95% Confidence interval
Hospitalisations	34.3	36.2	40.1	42.2	44.1	46.9	49.2	48.3	50.2	1.47	(1.44 - 1.49)
ADIS ⁸ treatment episodes	25.6	26.6	31.8	33.8	35.9	34.6	37.5	39.7	39.6	1.55	(1.51 - 1.58)
Ambulance presentations (metro Melbourne)	13.5	17.0	17.9	16.9	17.8	27.6	31.5	37.2	36.1	2.67	(2.59 - 2.75)
Alcohol-related Domestic Violence	16.5	19.3	20.0	24.1	22.9	24.3	22.8	23.6	26.1	1.58	(1.54 - 1.62)
Night-time assaults	9.0	10.1	10.8	10.6	10.3	11.4	12.4	13.5	12.8	1.42	(1.44 - 1.55)
ED ⁹ Presentations (intoxication)	5.0	5.3	5.6	6.2	6.9	7.5	8.2	9.3	9.9	1.98	(1.88 - 2.08)
Serious single vehicle night-time accidents	2.7	3.1	3.2	3.0	3.0	2.7	2.9	3.1	2.9	1.07	(0.99 - 1.50)
Mortality	1.6	1.5	1.5	1.6	1.5	1.5	1.5	1.5	1.4	0.89	(0.80 - 0.98)

⁷ Simple linear regressions of year against harm rates were also undertaken to test for the statistical significance of the trends across the time period. Significantly increasing trends were found for the first six harm types presented above, while trends for road accidents and mortality were non-significant.

⁸ Alcohol and Drug Information System

⁹ Emergency Department

Prevalence of risky drinking

Data on short-term risky drinking are presented in Figure 3. The Victorian Population Health Survey shows a gradually declining trend between 2002 and 2007 (the estimate for 2007 is statistically significantly different from the 2002 estimate), while the National Drug Strategy Household Survey estimates suggest there has been no change in short-term risky drinking across the period.

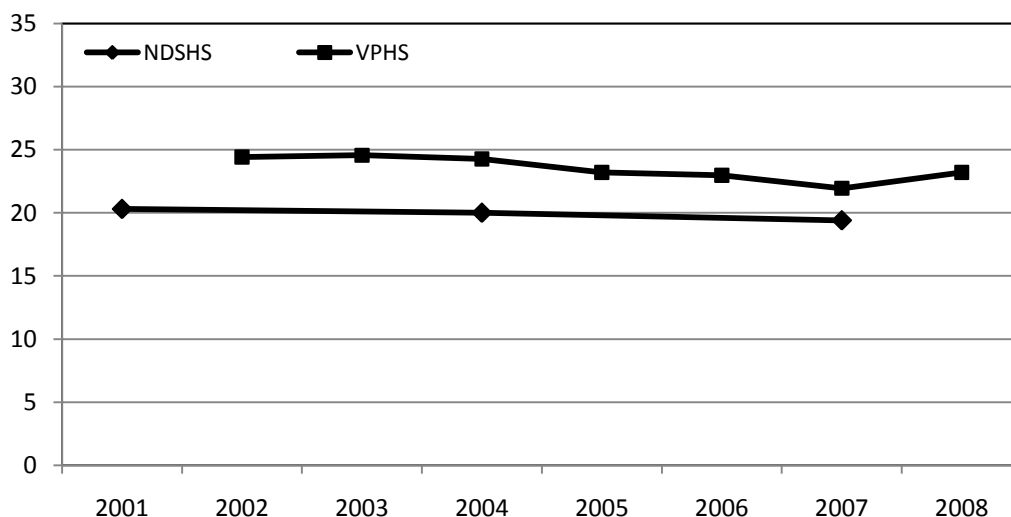


Figure 3 – Trends in the proportion of Victorians drinking at levels placing them at short-term risk of harm at least monthly, 2001-2008

The trends in long-term risky drinking in Victoria from the three relevant surveys are presented in Figure 4. The results from the National Drug Strategy Household Survey and the Victorian Population Health Survey both suggest that there has been little change in risky drinking over the last seven years, while the National Health Survey data shows a significant increase (from 9.3% to 12.1%) between 2001 and 2004, followed by a non-significant decline to 2007.

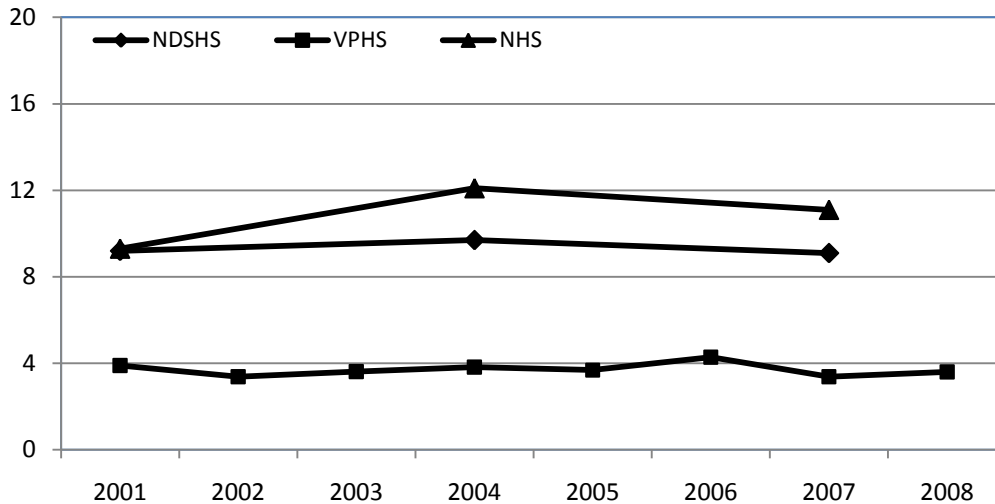


Figure 4 - Trends in the proportion of Victorians drinking at levels placing them at long-term risk, 2001-2008

Overall, there is little evidence of major changes in risky drinking levels in Victoria over recent years, while measures of alcohol-related harm suggest that problems from alcohol have increased dramatically. The potential implications of these diverging trends are discussed below, following the presentation of youth-specific trends.

3.4 Results for young people

To supplement the population trends presented above, this section provides a brief examination of trends amongst Victorians aged between 12 and 24, broken down into three age categories (based on the data sources available): 12 to 15, 16 to 17 and 18 to 24.

Alcohol-related harm

Rates of alcohol-caused hospitalisations and alcohol-intoxication emergency presentation for the three age groups under analysis are presented in Table 3. These data suggest a substantial upward trend in alcohol-related harm among young Victorians aged 16 and above. The hospital and emergency data show no marked changes amongst those aged 12 to 15 (although the small increase in the rate of emergency presentations for intoxication in this age group is statistically significant), but both show sharp increases for young people between 16 and 24. In particular, both data sources show particularly sharp increases amongst young people aged 18 to 24, with rates of alcohol-caused hospitalisations doubling and emergency presentations for intoxication nearly tripling over the nine-year period examined.

Table 3 – Trends in the rates (per 10,000) of alcohol-related harm experienced by Victorian young people, 1999/00 to 2007/08¹⁰

Harm type	Age group	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	Rate ratio (last yr/first yr)	95% Confidence interval
Hospitalisations	12-15	5.4	4.8	6.0	4.5	4.1	4.7	5.1	5.8	5.5	1.02	(0.81 - 1.28)
	16-17	10.2	9.1	10.8	10.4	10.2	11.3	13.0	16.0	14.4	1.41	(1.13 - 1.75)
	18-24	8.2	8.3	9.9	11.9	11.2	14.7	15.3	15.8	17.1	2.10	(1.82 - 2.31)
Emergency Department presentations (intox)	12-15	5.7	4.7	4.9	4.6	5.2	5.8	6.8	7.5	7.8	1.39	(1.12 - 1.71)
	16-17	11.1	9.4	10.7	12.7	13.2	15.0	18.2	23.7	23.7	2.14	(1.76 - 2.59)
	18-24	7.8	8.3	9.8	11.3	13.5	17.2	18.7	21.8	22.5	2.87	(2.57 - 3.22)

¹⁰ As in Table 2, simple linear regression tests of trends were undertaken on these data, with significant trends found across all measures and age groups with the exception of hospital admissions for 12 to 15 year olds.

Prevalence of risky drinking

Estimates of the prevalence of risky drinking for each of the three age groups under analysis are presented in Figures 5-7.

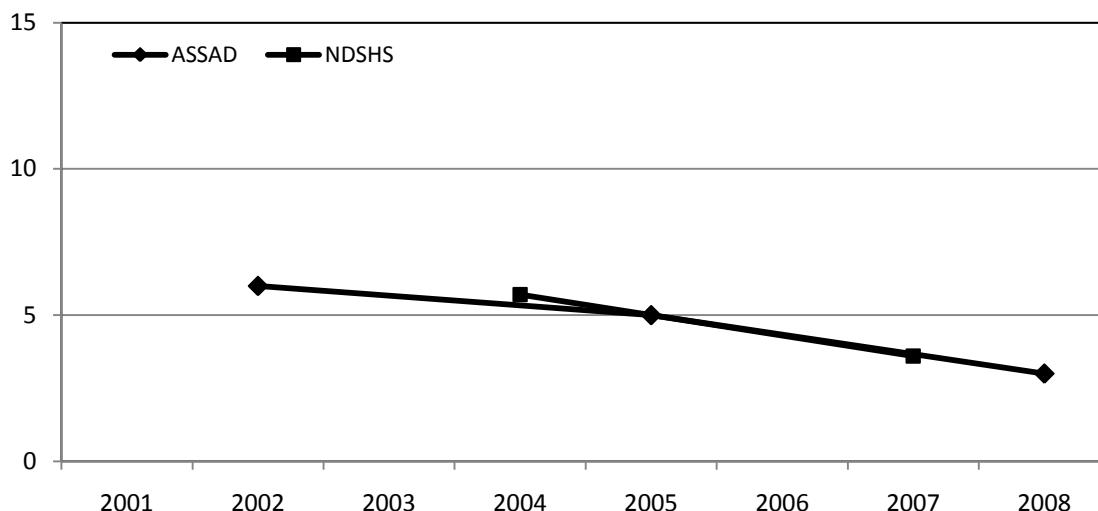


Figure 5 - Trends in the proportion of 12-15 year old Victorians drinking at levels placing them at short-term risk, 2001-2008

The two surveys that include 12 to 15 year olds both show declining trends in the prevalence of risky drinking amongst this age group. This decline is statistically significant over the three waves of the ASSAD survey, but the drop between the 2004 and 2007 NDSHS is non-significant. Regular risky drinking amongst this age group is a relatively rare behaviour, with less than 5% of young people engaging in it according to the most recent estimates.

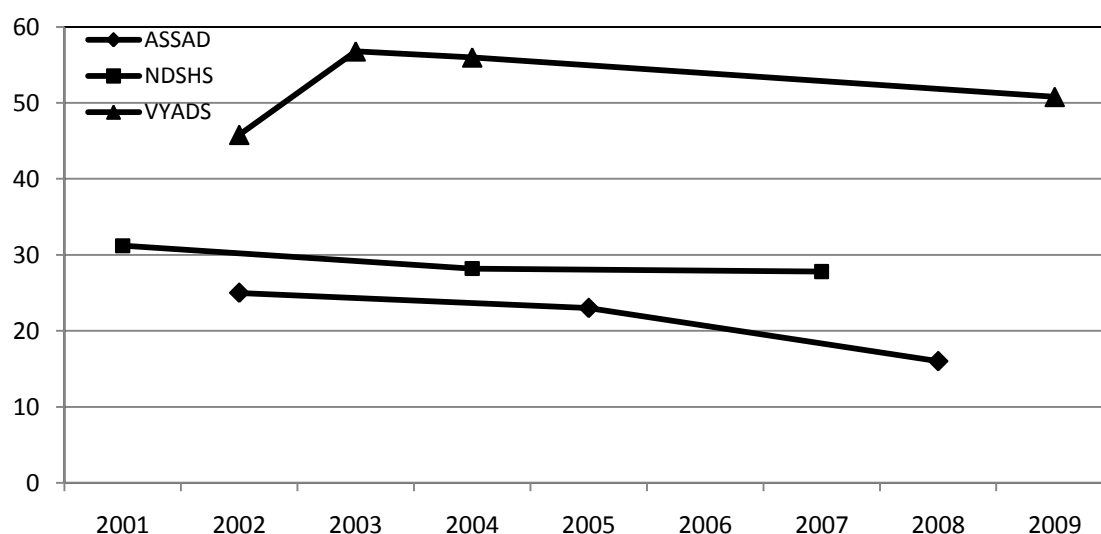


Figure 6 - Trends in the proportion of 16-17 year old Victorians drinking at levels placing them at short-term risk, 2001-2008

There was a significant increase in the prevalence of risky drinking for 16-17 year olds estimated using the VYADS survey between 2002 and 2003 (from 45.8% to 56.8%). However the post-2003 VYADS trend is a steady (non-significant) decline, matching the slight reductions observed in the estimates derived from the two other data sources. Thus, despite a blip in one data source, the general prevalence of risky drinking amongst 16-17 year olds in Victoria is estimated to have been stable or declining.

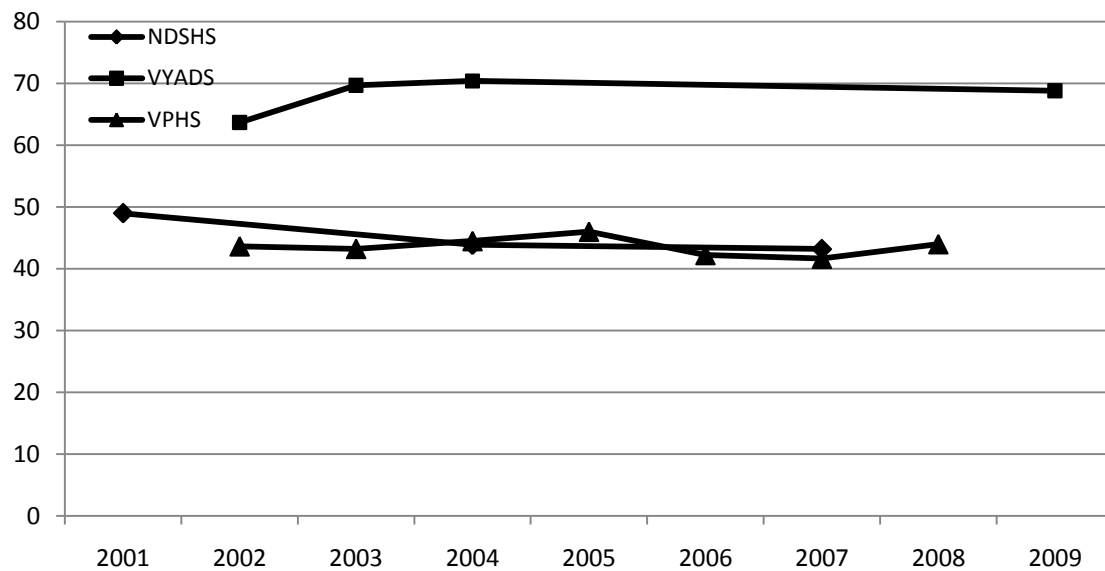


Figure 7 - Trends in the proportion of 18-24 year old Victorians drinking at levels placing them at short-term risk, 2001-2008

The trends in the oldest youth age group examined are consistent across the three studies utilised, with stable prevalence estimates across the time period. The higher estimates of risky drinking found in the VYADS study (for this age group and the 16-17 year olds) are noteworthy, and can't be explained by differences in the alcohol questions asked of respondents (VYADS and the NDSHS use exactly the same method to estimate consumption). It may reflect that the youth focussed survey does a better job at recruiting harder to reach respondents, who tend to drink at heavier levels than those that are easy to recruit (231), although as the other surveys don't provide age-specific response rates, this is hard to demonstrate empirically. Contrastingly, the sharp increase in risky drinking between the first two waves of the VYADS for both age groups raises some concerns over its comparability over time.

In general, the survey data present a striking contrast to the hospitalisation and emergency department data presented above, with no evidence of increasing risky consumption to explain the sharp increases in harm experienced by young people. This is a similar story to the results for the general population presented earlier in this chapter, with little evidence of changes in alcohol consumption during a period where a range of harms from alcohol have increased sharply.

3.5 Discussion

It is worth noting that measuring trends in alcohol consumption and alcohol-related problems is inherently problematic. The difficulties involved are described in detail in a WHO guide (217), and largely relate to the unreliability of most measures of alcohol involvement in health and social problems. Thus, in most cases indicators are based on surrogate measures of alcohol involvement. For example, as described earlier, alcohol-related hospital admissions are based on aetiological fractions, which are used to allocate certain proportions of admissions for various diagnoses as being caused by alcohol (e.g. all admissions for alcohol intoxication are considered alcohol-related, but only some proportion of admissions for assault injuries or breast cancer). Similarly, data recorded outside the health system (e.g. within the police system) seldom include accurate measures of alcohol involvement, so proxy measures such as assaults on Friday and Saturday evenings or single-vehicle night-time crashes are utilised. The main problem with these kinds of measures in monitoring trends is that factors other than alcohol can contribute to trends. For example, reductions in motor vehicle crashes due to campaigns to reduce driver fatigue will produce reductions in single-vehicle night-time crashes without any change in drink-driving behaviour. In addition, data from most of the sources presented here can be significantly influenced by changes to operational practices (e.g. coding or funding rules in hospitals, changes to policing priorities, changes to underlying data systems used). Generally speaking, mortality data is the most reliably recorded and accurately coded measure of those discussed here and the least likely to be influenced by factors unrelated to the underlying construct being measured (216). Given this, the lack of an increase in the measure used here raises some concerns about the reliability of the increasing trends found in the other indicators.

The use of a measure of alcohol-related mortality based on aetiological fractions may hide underlying changes in the actual prevalence of alcohol-related harm for a number of reasons. In the first place, changes in other factors relating to causes of mortality that alcohol contributes to (e.g. homicide, breast cancer, road traffic accidents) may counterbalance trends in alcohol specific incidents (216). In addition, trends in deaths from chronic alcohol consumption may lag behind changes in the more acute harms examined above. Thus, a measure of acute alcohol-specific mortality was examined to try to examine the divergence between the mortality and other trends presented above. This measure included only deaths wholly attributable to heavy drinking episodes (e.g. alcohol poisoning, alcohol-caused aspiration and acute intoxication) and is thus not susceptible to either of the two weaknesses discussed above. Data for this indicator are presented below in Figure 8.

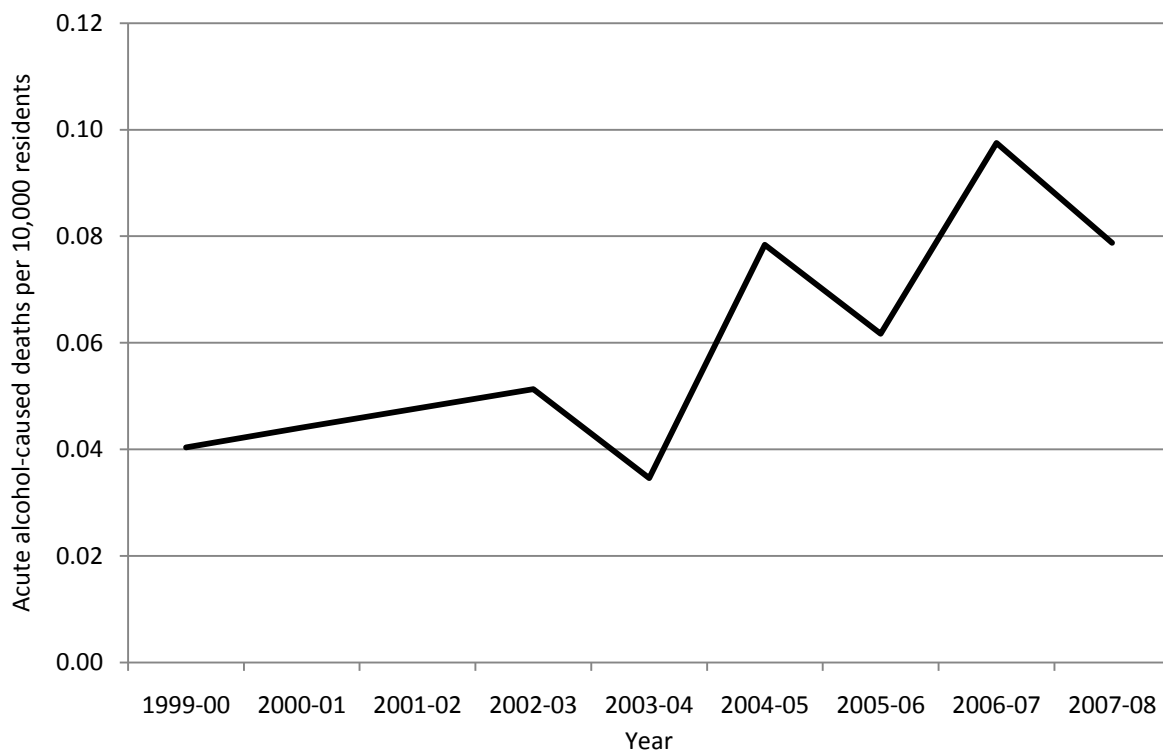


Figure 8 - Acute alcohol-caused deaths per 10,000 residents, Victoria, 1999/00 - 2007/08

The rate of acute alcohol-caused deaths (although based on small numbers of cases) has increased significantly across the time period under examination, with the rate roughly doubling. This is more in line with the trends presented earlier from other sources. Thus, despite various weaknesses regarding the specific indicators presented, there is relatively consistent evidence that the overall level of alcohol-related harm is actually increasing (although the slight decline in chronic alcohol-caused deaths is still hard to explain).

Similarly, the consistency of the age-specific trends in the youth sub-analyses are reassuring – changes in coding practices or other administrative changes within hospitals would be expected to have led to increases in the estimates of harm across all age groups, while both emergency and admissions data presented here suggested little change in the youngest group analysed (although this is based on relatively small numbers). There are potential explanations for the lack of an increase in single-vehicle night-time crashes, which are quite likely to have been kept in check by ongoing road safety measures including random breath testing (232), the introduction and expansion of speed cameras (233) and driver fatigue campaigns (234).

There are reasons to be cautious in interpreting the survey data presented here as well. In particular, response rates for most of the surveys indicate that these surveys are only covering around half of the target population. In addition, all surveys examined exclude people who are difficult to access for research (e.g. those who are homeless or in institutions like hospitals) or who do not have access to a landline telephone. Thus, there is the potential for the results presented here to reflect the trends only in a large subset of the population and not to cover some subgroups at particular risk of harm. There is some evidence from elsewhere that survey estimates of trends in alcohol consumption can point to erroneous conclusions. For example following recent cuts to the spirits tax in Finland, a 13% rise in a sales-based per-capita consumption measure over two years was undetected by surveys spanning the period, which found stable consumption (235). This suggests a need for more robust measures of per-capita consumption for Victoria, for which there are no viable estimates since sales data by state ceased to be routinely collected in 1997 (236). At this point, per-capita consumption is only available for Australia as a whole through estimates produced by the Australian Bureau of Statistics (237). These estimates have changed little in the last decade, suggesting relatively stable consumption, although it is possible that trends in Victoria differ from those for the whole country.

The divergence between the survey and register data may not necessarily be caused by weaknesses in either set of data. Instead, these findings may reflect changes in drinking behaviour within small, high-risk subpopulations, who are either excluded from surveys or whose number is too small to have much impact on population-based consumption measures, but who are increasingly experiencing alcohol-related harm. This hypothesis has been put

forward by Mäkelä and Österberg (238) to explain the relatively large impact on alcohol-related problems compared to per-capita consumption of a reduction in alcohol taxes in Finland, and is supported by a number of studies demonstrating higher impacts on harms than on consumption when policies change (85). Thus, it is possible that the ongoing increases in alcohol availability in Victoria have particularly affected the drinking patterns of high-risk drinkers, resulting in a substantial rise in alcohol-related harm without substantially altering population level estimates of drinking behaviour. For example, according to the 2001 National Drug Strategy Household Survey, 3.0% of Victorians aged 14 or older were drinking 7 or more drinks in a sitting at least once a week. Even if this proportion had increased to 5.0% by 2007 (an increase of 97,000 people), the survey estimates would not be statistically significantly different. Thus increases in particularly problematic behaviour amongst high-risk groups can conceivably take place without being detected even with unbiased survey estimates. Some support to this hypothesis is provided by specific analyses of very heavy drinking in the most recent VYADS survey. Despite the lack of trends in the generic measures of risky drinking examined above, the most recent survey report points to significant increases in the proportion of young people reporting drinking 20 or more drinks on an occasion from 26% in 2002 to 42% in 2009 (230, p12).

These changes in just the extreme end of the drinking distribution would not be in accordance with Skog's theory of the collectivity of drinking cultures, which would predict that in the aggregate the drinking of high-risk drinkers and of lower-risk drinkers would rise and fall together (239). However, in a later comment, Skog acknowledges essentially that this theory is subject to a *ceteris paribus* qualification. For example, he notes that as a result of changes in economic inequality or in gender roles, "group means could change in different rates and in different directions as societies change" (240). On its face, the current pattern of trends in Victoria suggests that a societal change may have occurred. The long march towards ever greater availability of alcohol, both in terms of declining prices relative to income (241, p.9) and in terms of the proliferation of drinking places and cut-price package stores (Figure 1), may be producing a change in the relationship between the drinking of lower-risk and high-risk drinkers, with a net result of considerably more problems per litre of alcohol. Clearly, this remains speculative, and further research into the cause of these increases in alcohol-related harm needs to be undertaken.

Despite the challenges of matching the survey and register data presented in this chapter, the data presented here provide a relatively convincing picture of sharply increasing harms from alcohol across a range of measures and data systems. This increase has occurred during a period of dramatic industry expansion (as presented in Figure 1) and with only limited impacts on alcohol consumption, outside of some potential increases in extremely heavy drinking. A small step in assessing the potential causal role of the increases in alcohol availability in these trends will be taken in the following chapter, which examines whether rates of extremely heavy drinking amongst young adults at the local level are associated with rates of alcohol availability in Victoria.

Chapter 4. Alcohol availability among other risk factors for young people's high-risk drinking in Victoria, Australia¹¹

4.1 Introduction

As outlined in the previous chapter, rates of alcohol-related harm amongst young adults in Victoria have increased substantially in recent years, while the proportion of this age-group that drink at levels defined as 'risky' by the National Health and Medical Research Council has been relatively stable. As discussed, this disparity may in part be explained by the increase in the proportion of young adults drinking at very heavy levels which has been identified across four waves of the Victorian Youth Alcohol and Drug Survey (VYADS) (230). In keeping with the broader aim of this thesis, this chapter aims to assess the potential association between this increase in very heavy drinking and the concurrent increases in alcohol outlet numbers in Victoria. Unfortunately, due to the limitations of cross-sectional survey waves, it is not possible to examine this question longitudinally. Instead, this chapter presents a cross-sectional multi-level analysis of the individual- and community-level correlates of very high-risk drinking amongst 16-24 year old Victorians, based on data from the 2003 and 2004 VYADS studies. The study focuses in particular on assessing the relationship between the density of alcohol outlets of various types in respondents' neighbourhoods and their heavy drinking behaviour.

Australian survey data show that heavy episodic drinking peaks in early adulthood, with 18-29 year olds substantially more likely to report short-term risky drinking than respondents in younger or older age groups (242, p55). This heavy episodic drinking is linked to a significant amount of harm. Recent analyses using Victorian data have found that the rates of alcohol-related road injury and alcohol-related assault victimisation for 15-24 year olds were around triple that of the whole population (243). In the most recent Australian burden of disease study, more than 10% of the health burden experienced in this age group was attributed to risky alcohol use (4).

¹¹ This chapter is based on: Livingston, M., A.M. Laslett, and P. Dietze, Individual and community correlates of young people's high-risk drinking in Victoria, Australia. *Drug and Alcohol Dependence*, 2008. 98(3): p. 241-248.

This study examines the predictors of heavy episodic drinking amongst young adults, paying particular attention to the role of alcohol outlet density. There are a range of plausible theoretical explanations for a causal link between the density of alcohol outlets and heavy drinking amongst young people. Firstly, a number of authors have suggested that the neighbourhood alcohol environment may influence and buttress social norms around alcohol (97, 173). This may result in young people who live in areas with more outlets feeling that alcohol use is more prevalent and normalised in their communities which, given the links between norms and heavy drinking (244, 245), is likely to result in more heavy drinking in those areas. Similarly, increased numbers of alcohol outlets in a young person's neighbourhood are likely to result in increased exposure to alcohol promotion (246), which is increasingly being linked to the development of heavier drinking behaviours (247). More directly, young people's drinking behaviour may be influenced straightforwardly by alcohol availability. Due to limited financial resources or poor planning, young adults' decisions to purchase alcohol may be affected substantially by the reduced convenience costs associated with higher densities of alcohol outlets. Finally, while there is little empirical evidence on the issue, economic theory would suggest that alcohol outlets in high outlet density areas will be forced into greater competition than those in more sparsely serviced suburbs and will thus be more likely to compete on price, resulting in lower alcohol prices. Research has demonstrated that young people's drinking is particularly price-responsive (248), so this would lead to more heavy drinking in areas of higher outlet density.

Predictors of heavy drinking amongst young adults

A range of studies have examined the correlates of heavy drinking amongst young people (using a range of definitions – generally drinking above specified levels), finding significant individual (249) and community level (250, 251) effects. Increasingly, researchers are focussing on models that incorporate both of these levels, providing a richer understanding of a range of outcomes (252). The following section will briefly review the literature in this area, focussing predominantly on the research into alcohol outlet density and heavy drinking.

Alcohol outlet density and drinking

Aggregate and multi-level studies of the relationship between the density of alcohol outlets and overall levels of alcohol consumption have produced mixed results. Studies using large

geographic units (nations or states) have generally identified some effect of outlet numbers on consumption levels, although the size and nature of these effects have varied significantly (162, 164). There have been few studies of total consumption using smaller geographic areas, and those that have been undertaken have again provided an inconsistent picture. Stockwell et al.'s study of post-privatisation British Columbia found that increases in off-premise outlet numbers (particularly private stores) at a local level were associated with significant increases in alcohol sales (90). In contrast, Gruenewald et al. used natural variation in licensing density at a zip-code level across a four year period, finding no significant associations between changes in density and changes in self-reported alcohol consumption (166).

Multi-level studies of drinking have increasingly focussed on the role of alcohol availability. At the general population level, the findings of these studies are inconsistent. A study across twenty-four New Orleans census tracts (97) found that neighbourhood-level outlet density was significantly related to drinking norms and consumption. Other studies have failed to detect strong relationships between alcohol availability and self-reported average consumption (168, 169). Recent work comparing New Orleans and Los Angeles suggests that the effects of outlet density on consumption are highly context-dependent, with significant associations between drinking volume and off-premise outlet density identified in New Orleans but not in Los Angeles (96). A handful of studies assessing the relationship between outlet density and heavy episodic consumption in the general population have produced more consistent findings, with studies in California, New Zealand and Melbourne all finding that people living in areas with higher off-premise outlet density were more likely to drink riskily (93, 98, 167).

Studies of adolescents, largely concentrating on initiation into drinking, have demonstrated some relationships between neighbourhood alcohol outlet density and drinking prevalence or initiation (102, 103, 173, 253), but this has not been a consistent finding (170-172). A multi-level study examining the relationship between outlet density and heavy consumption by New Zealand teenagers found a significant correlation, even with a range of individual-level correlates controlled (104).

Studies examining the role of alcohol outlet density in heavy drinking amongst young adults have been exclusively undertaken using college student samples. Initial work using a sample

from eight U.S. colleges found that the density of on- and off-premise outlets combined was associated with self-reported heavy drinking (5+ 12g standard drinks on at least one occasion in the last month), drinking frequency and drinking-related problems (101). This study was limited by the small number of sites included and the simplistic correlation approach to the analysis. Weitzman et al. extended this work, making use of a sample of students from across 120 colleges and utilising a more appropriate multi-level modelling approach (254), finding significant associations between community-level alcohol availability and the same measure of heavy drinking. In relying on self-reported measures of availability, this study was not strictly focussed on an objective measure of outlet density. Scribner et al. provide the most robust study, using objective measures of outlet density across 32 college campuses and more than seventeen thousand students in a genuinely multi-level design controlling for a broad range of individual-level factors (100). They found a significant relationship between heavy drinking and drinking frequency and on-premise outlet density, suggesting that in a U.S. context, college student drinking may be affected by the density of bars in the area surrounding college campuses. In the one study on this topic outside of the U.S., Kypri et al. (95) found significant positive associations between students' typical drinking quantities, alcohol-related problems and the density of alcohol outlets around six New Zealand universities. In contrast to the findings from the U.S., this study found substantially larger effects for off-premise outlets than for on-premise.

Thus, there is a small literature linking outlet density to heavy drinking among young adults, although it is entirely made up of studies of college students, a group that is unrepresentative of the broader population of young adults. The literature that exists suggests that there is generally a positive relationship between density and drinking, although the specifics of the relationship vary between the U.S. studies and the only non-U.S. study thus far.

Individual-level correlates of risky drinking among youth

The individual-level correlates of drinking among young people have been summarised in previous reviews (249, 255). Briefly, these studies have shown that heavy episodic drinking is related to a variety of individual, familial, school, peer and cultural factors (249).

Typically, individuals poorly integrated with their school, peers and family and living in disadvantaged social environments engage in socially negative behaviours such as risky drinking at a young age. Such findings are not surprising, given the social determinants of broader health behaviours and evidence in the literature on adult drinking behaviours (e.g.

256). However, the majority of studies conducted on youth drinking have focused on any drinking or risky or high risk drinking defined typically as around 5 or more drinks on any one occasion (257, 258). The place of alcohol in Australian culture means that these behaviours are commonplace, with such drinking often regarded as a ‘rite of passage’ (259). Therefore it is important to examine riskier drinking patterns (e.g. more than 10 drinks on an occasion) and whether the patterns of correlates and predictors of risky drinking patterns flow through to the very high risk drinking patterns examined in this study.

Other community-level correlates of drinking

In addition to the outlet density studies discussed previously, community-level effects on drinking and drinking-related harms have been investigated in studies in Australia and overseas, generally on adult populations (106, 260-262), with studies generally focussing on the relationship between area-level measures of poverty and/or inequality and rates of alcohol-related harms. Studies directly examining the link between neighbourhood socio-economic status and adult alcohol consumption have found mixed results (169, 263, 264), but more poverty is generally associated with more harm (264). There are marked variations in Australian consumption according to level of urbanisation with regional and rural locations associated with higher rates of drinking and harm than metropolitan areas (211, 265).

The current study

The current study analyses combined data from two waves (2003 and 2004) of the Victorian Youth Alcohol and Drug Surveys (VYADS). These surveys provide data on patterns and trends in alcohol and other drug use among young Victorians (aged 16 to 24). The study extends the previous literature in this area in two ways: firstly by examining a general population sample of young adults rather than a college student-only group, and secondly by considering levels of drinking substantially higher than are usually focussed on in studies of youth risky drinking. This study focuses on regular *very high risk* drinking patterns (males >20 Australian s¹² and females >11 Australian standard drinks per occasion at least twelve times in the last twelve months), which were reported by 18% of all respondents. The analysis presented below initially focuses on determining the key individual-level correlates of very high risk drinking. This is then extended using multi-level modelling to incorporate a

¹² Using the Australian standard drink definition, 10 g pure alcohol, in US standard drink measures, this is approximately 14.6 drinks for males and 8.0 drinks for females.

range of community-level factors, including alcohol outlet density, to determine whether these factors are associated with very high risk drinking over and above these individual-level correlates.

4.2 Methods

Survey methods

The data in this study come from the 2003 and 2004 VYAD Surveys conducted by a market research provider for the Victorian Premier's Drug Prevention Council. Computer Assisted Telephone Interviews were conducted with households selected at random from landline telephone numbers listed in the Electronic White Pages (EWP) for the Australian state of Victoria. This method excludes residents with unlisted numbers, as well as homeless or institutionalised people. Around 20% of Australian households have unlisted phone numbers (266). Australian samples selected using the EWP have been relatively unbiased on demographic and health-related variables compared with the more inclusive Random Digit Dial methodology (266, 267), although these studies did not examine young people. The use of a landline-based sample is likely to exclude a significant proportion of people aged 16 to 24 who use only a mobile telephone. Recent Australian estimates suggest as many as one-quarter of 16 to 24 year olds live in mobile phone only households, and that there is some variation in alcohol consumption between people living in these households and those living in households with a landline telephone (268). Thus, this study is likely to under-estimate youth heavy drinking. However, unless mobile-only households are geographically correlated with alcohol outlet density, this is unlikely to bias the findings of the main question being examined here.

Households with at least one resident aged between 16 and 24 were included in the sample. Where there was more than one appropriately aged resident in a household, one was selected at random to complete the survey. Parental permission was required for participants aged 16 or 17 years. Completed interviews were obtained for 6,052 young people in 2003 and 6,005 in 2004. Using the standards proposed by the American Association of Public Opinion Research (269), the response rate for the VYADS was approximately 58% across the surveys. Compared to population data, the sample slightly under-represented young people between 20 and 24, males and young people from rural areas. Data were weighted by sex, age, region

and the number of eligible residents in each household. Further technical details of the survey methodology are provided in the published survey reports (230).

The VYADS uses standard graduated quantity frequency questions, based on Australian standard drinks (10g pure alcohol), to measure consumption. This method for estimating alcohol consumption is the approach recommended by the World Health Organization (217) and, despite some specific issues with its validity for measuring overall consumption (270), is considered a reasonable way to detect risky drinking episodes (271)¹³. The relevant questions were: “In the last 12 months, how often have you had 20 or more standard drinks in a day”, and a similar question asking about consumption of 11 to 19 standard drinks in a day. The 2003 survey was undertaken in two repeated cross-sections; February-March and November-December. The 2004 survey was undertaken between December 2004 and January 2005. Exploratory analyses showed no effect of the time of year of data collection, so the samples were combined, producing a total sample of 12,057. As we were concerned with the difference between very high risk drinkers and other drinkers, only current (past 12 month) drinkers were included, producing a final sample of 10,879 (5,505 from 2003 and 5,374 from 2004). This sample resided in 568 different postcodes (our proxy for a community), an average of 19.2 respondents per postcode (minimum = 1, maximum = 144)¹⁴.

Dependent variable

The dependent variable for this study was twelve or more very high risk drinking episodes in the last year (henceforth referred to as ‘monthly’). Episodes were defined differently for males and females, using a similar approach to the 2001 NHMRC (225) Guidelines. For males, a very high risk drinking episode was a day in which twenty or more standard drinks were drunk. For females the cut off was eleven standard drinks. This split ensured broadly similar proportions of male and female drinkers classified as very high risk drinkers. The cut-offs used here are much higher than the short-term risky and high-risk categories defined by

¹³ Note that self-reported alcohol consumption in general has limited validity, typically under-estimating known consumption by between 30% and 50%. In terms of reliability, self-reported consumption measures are typically more robust. A detailed discussion of issues relating to self-reported alcohol consumption data is beyond the scope of this chapter, but interested readers can refer to authoritative reviews by Rehm and Midanik et al. (272, 273).

¹⁴ 78 respondents (0.7%) came from postcodes with only one respondent. Multilevel models were run both including and excluding these respondents, with no meaningful difference in the results.

the NHMRC typically used in Australian studies (e.g. 274) and the 5+ measure typically used in U.S. studies of binge drinking (e.g. 101), ensuring that this study focuses on a group of particularly vulnerable young drinkers. There are concerns about the reliability of self-reported alcohol consumption data, although recent studies have found that self-report telephone interviews produce generally reliable estimates of consumption, particularly when dealing with regular drinking behaviours such as those examined in this study (275).

Survey-derived independent variables

A range of demographic factors was included: gender (male, female), age group (16-17, 18-21, 22-24), life stage (still at secondary school, working, undertaking post-school study, other). Gender, age and life stage have all been repeatedly shown to be related to drinking behaviour in Australia (e.g. 242). Cultural background was also included, based on a relatively crude measure – whether the main language spoken in the respondent’s household was English or another language¹⁵. Australian research into youth drinking has often highlighted the lower prevalence of risky drinking amongst respondents from non-Anglo cultures (e.g. 276), so language spoken at home was considered an appropriate control variable. The respondent’s Indigenous status was also controlled for, given the substantial differences between non-Indigenous and Indigenous drinking patterns in Australia (277).

The respondent’s household situation (living with both parents, living with one parent, living with partner, other) was also included, given the evidence that drinking levels are significantly affected by these factors (278-282). A measure of recreational income was also collected; with respondents asked how much money they had available for such purposes each week (less than \$80, \$80 or more). Given the evidence that young people’s drinking is significantly affected by price (248), financial considerations were considered likely to be correlated with drinking behaviour.

¹⁵ The non-English speaking households came from a diverse set of backgrounds, with Mandarin (10.7%), Cantonese (8.5%), Vietnamese (7.5%) and Arabic (6.4%) the most commonly specified. In addition, 22.2% of non-English speaking households spoke an ‘other Asian language’ and 18.7% spoke an ‘other European language’.

Respondents were asked about family conflict, which has been linked to youth drinking (283). Specifically, respondents were asked: whether or not people in their family, often insulted or yelled at each other, had serious arguments, or argued about the same things over and over. While there were significant correlations between these measures, the correlation coefficients were less than 0.6, so these three measures were included separately in the analysis.

Finally, respondents were asked the age at which they first consumed a full drink of alcohol (13 or younger, 14 to 15, 16 to 17, 18+). Age of initiation of drinking has a robust association with subsequent heavy drinking and was thus a critical variable in this analysis (284, 285).

Community-level independent variables

Postcodes were used to approximate the respondents' communities. Respondents were asked their postcode of residence and, where not available, they were extracted from the Electronic White Pages, based on the respondent's telephone number, ensuring that no respondents had missing postcode data. We could therefore include variables relating to the community in which young people lived: socioeconomic advantage/disadvantage, geographic remoteness and alcohol outlet density.

Advantage/Disadvantage was derived from the suite of indexes in the Socio-Economic Index for Areas (SEIFA) (286). The Australian Bureau of Statistics (ABS) developed the SEIFA indices using Principal Components Analysis on data collected during the 2001 Census. The index that summarises the level of socio-economic advantage of a neighbourhood based on a range of variables including income, education levels, employment, living conditions and wealth (full details of the index derivation are available in 286) was used here. The index was divided into quartiles, with quartile one containing the most disadvantaged quarter of the Victorian population and quartile four the most advantaged.

Remoteness was derived from the Australian Remoteness Index for Areas (ARIA+), which assigns a remoteness score to regions based on the road distances to population and service centres (287). A standard set of five categories for the ARIA+ index has been developed by the ABS: major cities, inner regional, outer regional, remote and very remote. Victoria has

few remote postcodes, so the three most remote categories were combined into a single category, producing three categories of remoteness (major city, inner-regional, remote).

Alcohol outlet density measures were created using active licence address data provided by the state licensing authority - Liquor Licensing Victoria. As postcode and licence type were provided for each licence, we calculated the rate of different types of licences at the postcode level. As population estimates for postcodes in Victoria are only available for Census years, the licence rates were calculated using 2001 licensing data. Outlet density was calculated as the number of licences per 10,000 residents for each postcode for three different types of licence: general (incorporating hotels and taverns), packaged (off-premise liquor outlets) and on-premise (restaurants and bars). The licensing data was discussed in detail in Chapter 2.

Analysis

All statistical analyses were undertaken using R (288). Generalised linear mixed models with a logit link function and random intercepts were developed using the ‘lmer’ function in the R package ‘lme4’. The models were estimated using Laplacian likelihood estimators. The individual-level factors derived from the survey were included at the first level (respondent) and the three postcode level variables were included at the second level (postcode). Model 1 included only the individual-level factors, while allowing the model intercept to vary randomly between postcodes. Model 2 included the community-level explanatory factors to ascertain whether they were significantly related to youth high-risk drinking over and above the individual characteristics of the participants. The specific model used was a logistic multi-level model:

$$\log[\Pr(Y_{ij})/1-\Pr(Y_{ij})] = \beta_0 + \beta_{1j}x_{ij} + \beta_2w_j + u_{0j}$$

Where:

$\Pr(Y_{ij})$ = the probability that respondent i in neighbourhood j drinks at very high risk levels

β_0 = the overall mean probability of very high-risk drinking

β_{nj} = the vector of n individual-level parameters for neighbourhood j

X_{nij} = the vector of n individual characteristics for individual i in neighbourhood j

B_m = the vector of m neighbourhood level parameters (random effects)

W_{mj} = the vector of m neighbourhood level characteristics in neighbourhood j

u_{0j} = the random neighbourhood slope coefficient

In other words, the probability of binge drinking is made up of an overall intercept term (β_0), the effect of individual characteristics within each neighbourhood ($\beta_{1j}x_{ij}$), the effect of neighbourhood characteristics ($\beta_{2j}w_j$) and a term capturing the remaining neighbourhood level variation (U_{0j}).

The intra-class correlations of the study's individual level variables due to the clustering of respondents in postcodes were statistically significant (between 0.004 and 0.08), warranting the multi-level approach undertaken.

4.3 Results

Around 18% (2,167) of the sample reported monthly very high risk drinking. An initial exploration of the association between gender, age and very high risk drinking showed a non-linear relationship. Male and female rates of very high risk drinking were similar for the younger respondents, but while the rate for females decreased as age increased from nineteen to twenty-four, the male rate remained stable (Table 4). Therefore, we analysed age as a categorical variable and its interaction with gender was included in all analyses.

Table 4 summarises the sample distributions of the individual-level explanatory factors and presents the bivariate relationships between them and the prevalence of reported very high risk drinking. Significant differences in the rate of very high risk drinking for all of the contextual factors considered were evident, with the exception of Indigenous status. Young people from an English-speaking background, who were working, who were living with a single parent or in an ‘other’ household type, who had \$80 or more in weekly recreational spending money, who experienced familial conflict or had initiated drinking at a young age were more likely to report very high risk drinking than their counterparts.

Table 4 – Sample distributions and very high risk drinking prevalence, VYAD surveys 2003 and 2004 (drinkers only), weighted data

Factor	N	Percentage of sample	Percentage high-risk drinking (19.9% overall)	P-value (two-tailed χ^2)
Gender and age				
Male 16-17	1,024	9.4%	14.6	
Male 18-21	2,867	26.4%	25.1	
Male 22-24	1,640	15.1%	24.5	
Female 16-17	987	9.1%	14.4	
Female 18-21	2,683	24.7%	22.1	
Female 22-24	1,674	15.4%	16.7	<0.001
Cultural background				
English speaking	10,114	93.0%	21.9%	
Non-English speaking	762	7.0%	8.8%	<0.001
Indigenous status				
Indigenous	188	1.7%	22.3%	
Non-Indigenous	10,687	98.3%	21.0%	0.647
Life stage				
At secondary school	1,800	16.6%	13.3%	
Working	4,935	45.4%	25.4%	
Post-school study	2,924	26.9%	19.5%	
Other	1,216	11.2%	18.0%	<0.001
Household situation				
Living with both parents	6,082	56.0%	18.6%	
Living with one parent	1,637	15.1%	23.7%	
Living with partner	1,030	9.5%	16.6%	
Other living arrangements	2,116	19.5%	27.9%	<0.001
Weekly recreational spending money				
Less than \$80	4,453	40.9%	14.3%	
\$80 or more	6,423	59.1%	25.7%	<0.001
Age at first drink				
13 or younger	1,837	17.0%	31.1%	
14 to 15	4,269	39.5%	24.7%	
16 to 17	3,736	34.6%	15.8%	
18 or older	956	8.9%	5.9%	<0.001

Serious family arguments				
Yes	1,641	15.2%	26.7%	
No	9,183	84.8%	20.0%	<0.001
Repeated family arguments about the same things				
Yes	4,339	40.1%	23.4%	
No	6,285	59.9%	19.4%	<0.001
Family often insult/yell at each other				
Yes	1,892	17.5%	26.7%	
No	8,940	82.5%	19.7%	<0.001

Table 5 and Table 6 provide summaries of the relationships between reported very high risk drinking and community-level variables. Young people living in metropolitan areas or were less likely to report very high risk drinking than those in regional or remote areas. Due to the small number of respondents in remote postcodes and the similar rates of reported very high risk drinking in remote and regional areas, the remoteness variable was recoded into just two categories (major city and inner-regional/remote) for subsequent analyses. Very high risk drinking did not have a clear association with socio-economic disadvantage, with the highest prevalence observed in one of the middle quartiles.

Table 5 – Community-level variable distributions and relationship to prevalence of very high risk youth drinking, VYAD surveys 2003 and 2004 (drinkers only), weighted data

Factor	N	Percentage of sample	Percentage high-risk drinking (19.9% overall)	P-value (two-tailed χ^2)
SEIFA quartile				
1 (most disadvantaged)	2,017	18.6%	21.1%	
2	2,307	21.3%	23.3%	
3	2,766	25.5%	20.6%	
4 (least disadvantaged)	3,766	34.7%	19.8%	0.011*
Remoteness				
Metropolitan	8,169	75.2%	19.8%	
Inner regional	2,638	24.3%	24.6%	
Outer regional/remote	49	0.5%	26.5%	<0.001**

In terms of outlet density, very high-risk drinkers lived in neighbourhoods with marginally higher median levels of general and on-premise outlets.

Table 6 – Median outlet density for postcode of residence of VYADS respondents, by type of outlet and drinking behaviour.

	Median outlet density		
	General Licences	Packaged Licences	On Premise Licences
Very high risk drinkers	5.1	3.4	9.2
Other drinkers	4.4	2.9	8.7
Total	4.5	3.0	8.8
P-value (Mann-Whitney U)	<0.001**	0.096	0.046*

Multilevel modelling

The results from the multilevel modelling shown in Table 7 are consistent with the bi-variate relationships presented above. While females aged between 22 and 24 were less likely than similarly aged males to report very high risk drinking, there were no significant differences between younger males and females. Across both genders, people aged 18 or over were more likely than their underage counterparts to report drinking at very high risk levels. Each type of family conflict was associated with a similar increase in the odds of very high risk drinking. Young people living with a partner were the least likely to report very high risk drinking, while those living in single-parent families or in ‘other’ household structures were more likely than those living with two parents to report such drinking. Young people who were still at secondary school were less likely to report very high risk drinking, while there were no significant differences between those working, undertaking post-school study or in other employment situations (unemployed, home-duties etc). Young people who had \$80 or more to spend on recreation each week around 1.8 times as likely to report very high risk drinking. Young people from non-English speaking backgrounds were about half as likely as those from English speaking backgrounds to report very high risk drinking. Finally, the age at which a young person first consumed alcohol was strongly related to reported very high risk drinking, with the odds decreasing as the age of initiation increased. Including the effect of postcode in the first model provided some improvement over a simple single-level logistic model ($\chi^2=10.76$, $p=0.001$). This model improvement was verified by a reduction in the Akaike Information Criteria (AIC) from 9869 to 9838. The inclusion of neighbourhood-level variables also reduced the amount of unexplained variance at the postcode level (the intra-class coefficient), from 4.3% in Model 1 to 2.9% in Model 2.

Table 7 – Model parameters for logistic regression models of very high risk drinking.

Variable	Model 1 – Individual-level parameters only		Model 2 – multi-level model	
	Odds Ratio	95% CI	Odds Ratio	95% CI
Demographics				
<i>Gender</i>				
Male	1		1	
Female	1.010	0.780-1.309	1.005	0.775-1.303
<i>Age group</i>				
16-17	1		1	
18-21	1.446	1.108-1.887**	1.493	1.142-1.950**
22-24	1.314	0.986-1.750	1.423	1.066-1.899*
<i>Gender * age group¹⁶</i>				
Female: 18-21	0.909	0.679-1.216	0.928	0.693-1.243
Female: 22-24	0.661	0.482-0.906*	0.661	0.482-0.908*
Cultural background				
<i>Language spoken at home</i>				
English	1		1	
Non-English	0.411	0.313-0.540**	0.434	0.330-0.571**
<i>Indigenous status</i>				
Non-Indigenous	1		1	
Indigenous	1.166	0.804-1.691	1.148	0.792-1.665
Family dysfunction				
<i>Family repeated arguments</i>				
No	1		1	
Yes	1.129	1.012-1.259*	1.146	1.027-1.279*
<i>Family serious arguments</i>				
No	1		1	
Yes	1.171	1.008-1.360*	1.170	1.007-1.359*
<i>Family Insult/yell at each other</i>				
No	1		1	
Yes	1.241	1.073-1.434**	1.248	1.080-1.444**

¹⁶ Note that the reference categories for the interaction term are the male odds ratios for the particular age groups. In other words, 22-24 year old females are 0.66 times as likely as 22-24 year old males to drink at risky levels.

Life stage				
<i>Household situation</i>				
Living with both parents	1		1	
Living with one parent	1.233	1.073-1.417**	1.238	1.077-1.424**
Living with partner	0.712	0.712-0.867**	0.687	0.564-0.837**
Other living arrangements	1.521	1.521-1.739**	1.509	1.318-1.728**
<i>Education/employment</i>				
At secondary school	1		1	
Working	1.743	1.358-2.237**	1.708	1.329-2.195**
Post-school study	1.348	1.043-1.743*	1.356	1.048-1.755*
Other	1.387	1.053-1.828*	1.351	1.024-1.783*
<i>Weekly recreational spending money</i>				
Less than \$80	1		1	
\$80 or more	1.754	1.563-1.970**	1.768	1.574-1.986**
Age at first drink				
13 or younger	1		1	
14 to 15	1.067	0.798-1.425	1.055	0.790-1.410
16 to 17	0.592	0.443-0.790**	0.583	0.436-0.778**
18 or older	0.266	0.194-0.366**	0.257	0.187-0.353**
Community Variables				
<i>SEIFA quartile</i>				
1 (most disadvantaged)			1	
2			1.179	0.987-1.409
3			1.003	0.826-1.217
4 (least disadvantaged)			0.944	0.770-1.156
<i>Remoteness</i>				
Metropolitan			1	
Inner regional/remote			1.274	1.079-1.504**
<i>Liquor license density</i>				
General licences			1.001	0.992-1.011
Packaged licences			1.031	1.016-1.046**
On-Premise licences			1.000	0.994-1.006
Random effect (variance between postcodes)	0.053		0.035	
Akaike Information Criteria (AIC)	9869		9838	
Intra-class coefficient (ICC)	4.3%		2.9%	

* p<0.05

** p < 0.01

The results for model 2, including both individual and postcode level predictors, show almost no changes to the parameter estimates for the individual-level predictors once community-level variables were included. Of the three community-level variables, remoteness and outlet density were significant in the model. Young people living in non-metropolitan areas were 1.3 times more likely to report very high risk drinking than young people living in major cities. Increased density of packaged liquor outlets was associated with increased prevalence of very high risk drinking among the young people in our sample. The densities of the remaining licence types were not associated with changes in the prevalence of very high risk drinking. Further, the socio-economic disadvantage of a young person's community was not significantly related to reported very high risk drinking behaviour. A log-likelihood test comparing model 2 to model 1 showed that the inclusion of the community-level predictors produced a significantly better model ($\chi^2=46.3$, $p<0.001$). Tests for multicollinearity found no major problems stemming from correlation between the independent variables.

4.4 Discussion

Individual correlates

The criteria used in this study for defining very high risk drinking, 20 standard drinks for males and 11 standard drinks for females, are relatively high in comparison to most studies, probably more closely resembling the lay concept of what constitutes "binge" drinking. A substantial proportion of this sample of young people reported monthly or more frequent drinking at these levels.

The pattern of effects of the individual-level correlates examined was largely consistent across all of the analyses, and was also largely consistent with previous work (see 255). The age effects observed accorded with other Australian work (242) and the protective effect of later initiation into drinking was consistent with findings in previous research (289), suggesting an ongoing focus on early intervention and prevention is required. The age by gender interaction showed a decrease in the rate of very high risk drinking among females in their mid 20s. Similar findings are evident in prospective studies which have shown, for example, that the amount drunk per occasion by women peaks earlier and begins to decline before that for men (258).

The remaining individual correlates highlight the impact of cultural, social and economic factors on rates of very high risk drinking among the sample. While people from non-English speaking backgrounds were less likely to report very high risk drinking, Indigenous respondents reported very high risk drinking at the same frequency as the remainder of the sample. Importantly, the extent of family dysfunction (characterised here by negative family relations - arguments/insults) was associated with increased reporting of very high risk drinking in accordance with previous cross-sectional and prospective studies (255). The relationships between higher amounts of disposable income for recreational spending, as well as participation in the workforce, and increased rates of reported very high risk drinking highlight the economic drivers of very high risk drinking in this age group. This finding further emphasises that mechanisms such as increased taxation or prevention of price discounting (e.g. 'happy hours') are likely to have the greatest effect among young people (184).

Community-level correlates

In addition to individual-level variables, this study examined a number of community-level variables in our multilevel modelling. The absence of any effects of area-level sociodemographics (summarised in the SEIFA index) on very high risk drinking was consistent with much of the literature in the area, which finds little socio-economic variation in consumption despite substantial inequalities in harm rates (185, 264). Remoteness (i.e. regional and remote postcodes) was associated with an increased prevalence of very high risk drinking. This is consistent with a large body of previous research in Australia that shows that rates of high-risk are highest in the more remote areas of the country (242).

Outlet density findings

The association between packaged liquor outlet density and reported very high risk drinking is important and supports the findings of the only previous non-U.S. study of the effects of outlet density on heavy drinking by young adults (95), which found that packaged liquor outlets were the most important outlet type associated with drinking behaviour in this age group. The results of this study do not provide a definitive means for assessing which of the potential mechanisms discussed earlier is driving the association between the density of packaged liquor outlets and heavy drinking amongst young Victorians. For example, the VYADS did not collect information on alcohol-related norms or expectancies, so this study could not explore whether outlet density was associated indirectly with drinking patterns via

its impact on beliefs about alcohol. The significant association between recreational income and heavy drinking in the sample highlights the importance of financial considerations in the drinking choices of the sample. This provides some small hint that the any effects of outlet density on very heavy drinking may be occurring through the effects of density on pricing and discounting behaviours by retailers, although there has been no empirical research on this question either in Australia or elsewhere. In Australia, alcohol consumed in on-premise settings is between two and five times as expensive as that purchased from packaged liquor outlets (290), and price is likely to be a key concern of young people drinking at such high levels.

While the effect found in this study appears modest (1.035), the model findings suggest that an increase of one packaged liquor outlet in a postcode with 200 very high risk young drinkers (from a total population of 1000 young people) would be expected to be associated with an increase of approximately 6 extra young people drinking at such levels. Indeed, given the substantial increase in the number of packaged liquor outlets in the last decade in Victoria (see Figure 1), this relationship may in part explain the substantial increase in very heavy drinking discussed in the previous chapter. The lack of significant associations between the two other types of outlet density were slightly surprising in the context of the findings of the U.S. literature (100), although this may simply reflect differences between college student samples and the general youth population.

It is worth noting that the cross-sectional nature of this study limits the degree to which this link can be considered causal. There is a significant possibility that heavy drinking young people (particularly those that have moved out of their parent's home) intentionally move into neighbourhoods with a ready access to alcohol. Further, the association found here may be driven by the effects of some unmeasured third factor correlated with both packaged liquor outlet density and youth heavy drinking prevalence. In spite of these limitations, the results found here provide some suggestion that alcohol outlet density is a contributor to very heavy drinking by young adults in Victoria and thus implies the possibility that the increases in alcohol outlet densities that have occurred in the state in recent years have been partly responsible for the concurrent rise in harm from alcohol. This will be specifically tested across the next three chapters of this thesis, which will specifically examine the cross-

sectional and longitudinal relationships between alcohol outlet density and a range of harms related to alcohol.

Chapter 5. Alcohol outlet density and assault¹⁷

5.1 Introduction

This chapter presents two small-area studies of the association between alcohol outlet density and general violence in Melbourne, Australia. The first is a cross-sectional analysis which aims to assess the specific nature of the relationship between outlet density and violence, extending the previous literature in three ways: by examining whether the effects of outlet density on violence interact with measures of socio-economic disadvantage; by exploring how outlet density in neighbouring areas relates to local levels of violence; and by assessing whether non-linear relationships exist between outlet density and violence, thus implying saturation or threshold effects. The second study is a cross-sectional time-series analysis using fixed effects models to undertake a longitudinal analysis of the relationship between changes in outlet density and changes in violence. This analysis is extended by exploring the longitudinal relationships between outlet density and violence in various types of neighbourhood. The specific details of each study will be provided in full below.

The chapter will begin with a broad overview of the theoretical and empirical literature linking alcohol outlets and violence. This will be followed by the presentation of each of the empirical studies before the final section discusses their findings and implications in the broader context of this thesis.

Alcohol and violence

The association between alcohol and violence has been well established in the public health and criminological literature, both in terms of perpetration and victimisation (291-293). Reviews of epidemiological studies highlight the substantial increases in risk of being assaulted that come with alcohol consumption. For example, a recent systematic review and meta-analysis undertaken for the Global Burden of Disease project found that each drink

¹⁷ This chapter incorporates work taken from three publications:

Livingston, M., T. Chikritzhs, and R. Room, Changing the Density of Alcohol Outlets to Reduce Alcohol-Related Problems. *Drug and Alcohol Review*, 2007. 26: p. 557-566.

Livingston, M., Alcohol outlet density and assault: a spatial analysis. *Addiction*, 2008. 103(4): p. 619-628.

Livingston, M., A Longitudinal Analysis of Alcohol Outlet Density and Assault. *Alcoholism: Clinical and Experimental Research*, 2008. 32(6): p. 1074-1079.

consumed during a drinking occasion increased the odds of experiencing an intentional injury (i.e. an injury from an assault) by 38% (294). Similarly, a review of emergency department studies found the strongest association between drinking and injury for violence-related presentations (295). Reviews of the criminological literature also demonstrate substantial associations between alcohol consumption and assault perpetration (e.g. 296). In Australia, around a quarter of offenders detained for violent offences directly attribute their offending to their drinking behaviour (5), while large studies of assault victimisation in the general population estimate that around half of assaults were in part related to the alcohol consumption of the perpetrator (297). A growing number of experimental studies have been undertaken to try to overcome the inherent weaknesses in the correlational or self-attribution studies that dominate the field, finding in controlled situations that increased alcohol consumption is associated with increased aggression, at least among people predisposed to be aggressive (e.g. 298, 299, 300). Further, rates of violence at the population level have been shown to respond to alcohol pricing and other alcohol control policies (42), suggesting that rates of violence can be affected by policies focussed on alcohol. It is worth noting here that, despite the general agreement in the research literature that alcohol consumption has a causal link to violence, the nature and the size of the association vary substantially between settings, population sub-groups and cultures, suggesting complex pathways between drinking and violence (301).

The theoretical attempts to flesh out these pathways and develop coherent explanations of the links between alcohol consumption, intoxication and violence are varied and are not the key focus of this chapter. Thus, they will only be briefly summarised here, with interested readers referred to Peranen's comprehensive book on the subject (291). A number of theoretical explanations for a causal relationship between alcohol consumption and violence have been put forward. Graham et al. identified more than fifty explanations put forward in the research literature, covering everything from the biological and cognitive effects of alcohol and their effects on individuals' decision making through to the cultural and social norms associated with intoxication in particular societies (302). In a follow-up to this review, Graham and colleagues examine detailed narrative accounts of more than one-hundred incidents of violence to explore the relevance of particular explanatory theories. They found that violent incidents stem from a complex web of causes, including both individual-level effects of alcohol and effects related to the drinking environment. In particular, at the individual level,

they suggested that alcohol's association with increased risk-taking, cognitive impairment and elevated emotionality made it more likely that intoxicated people would become embroiled in aggressive situations and would be less likely to be able to make decisions that would defuse rather than escalate these situations (303). Their findings also point to the aggressively masculine sub-cultures of some drinking places and the general air of permissiveness in many drinking environments as key environmental factors that lead to increased violence in places that alcohol is consumed. Parker and Rebhun (304) have suggested that a process of 'selective disinhibition' ties together the individual and context based explanations for the links between alcohol and violence. In their formulation, the likelihood of being involved in violence (a generally proscribed behaviour) increases only when the disinhibition that comes with intoxication is combined with social or contextual cues that reduce the general social constraints on violence.

The literature thus points to a clear association between alcohol consumption and violence, with the specific effects of alcohol on individual drinkers working in conjunction with social and contextual factors to result in violent incidents. In the context of this general association, the empirical findings that per-capita alcohol consumption is associated with population levels of violence are not surprising, particularly as the association varies substantially between cultures, reflecting differences in drinking patterns and in the socio-cultural norms and expectancies linking alcohol and violence (305-308).

Alcohol availability and violence

Theoretical underpinnings

Given the broad associations discussed above, there is an obvious theoretical reason to examine the relationship between alcohol availability and violence: if alcohol consumption is causally related to violence and, as has been generally shown in the public health literature (42), alcohol availability is related to alcohol consumption, then it is implied that changes to alcohol availability will result in changes to violence rates. As discussed in the introduction to this thesis, this explanatory approach is referred to as 'availability theory', and has been expanded to incorporate the effects of availability changes on where and how as well as how much alcohol is consumed (67). However, while there is generally strong evidence that large changes in alcohol availability affect alcohol consumption levels, the evidence for the relationship between outlet density and alcohol consumption (as outlined in the previous

chapter) is more mixed. This is especially true when compared to the consistency of the evidence linking alcohol outlet density to rates of violence (see reviews: 48, 49, 73, 177). Thus, when it comes to the association between alcohol outlet density and violence there is some disparity between the relatively straightforward approach suggested by availability theory and the state of the evidence.

To help address this disparity, researchers have utilised a number of theoretical approaches to explain a direct link between outlet density and violence not necessarily mediated by alcohol consumption, predominantly derived from the criminology literature. Routine activities theory attempts to explain violent crime such as assault as being a basic product of a situation whereby a motivated offender is in contact with a target, in the absence of both capable guardians (e.g. police, security staff) and intimate handlers (e.g. parents, spouse, friends) (68). It has been suggested that alcohol outlets produce situations conducive to violence by attracting possible offenders; increasing the numbers of vulnerable potential victims; removing the presence of capable guardians; and separating possible offenders from their intimate handlers (106). Thus, changes in alcohol outlet densities will change the routine activities of potential offenders and victims, resulting in more potentially violent situations and increased rates of violence. Another approach used by some researchers (e.g. 72) has been to apply social disorganisation theory (71), which is based on the idea that crime rates are heavily influenced by levels of informal social control. Thus, neighbourhoods with limited social organisation (sometimes operationalised as collective efficacy (309) or social capital (310)) will have lower levels of informal social control and will provide places where potential offenders feel more able to commit violent crime without sanction. Alcohol outlets have been put forward by some authors as markers of social disorganisation, based both on the possibility that better organised neighbourhoods are better equipped to resist the encroachment of problematic venues and the perception of alcohol outlets as places with reduced social constraints on behaviours that would be problematic in other settings (311).

In recent work, Gruenewald has put forward the idea that the effects of outlet density on violence are driven by the increasing segmentation of alcohol consumers that is possible as outlet numbers increase (73). In his 'niche theory', as outlet numbers increase, venue operators need to increasingly differentiate themselves to compete effectively, and thus target their operations to particular niches of the drinking population. Consumers respond to this

targeting in an assortative process that results in the increased division of the drinking population into socio-cultural sub-groups drinking in different venues. Gruenewald's hypothesis is that this sorting of drinkers will increasingly concentrate violence-prone drinkers in the same venues, as these venues target this particular segment of the drinking population. This resonates with the environmental factors put forward by Graham et al. and briefly discussed earlier (303). In their study for example, the 'macho-ness' of a venue was a key driver of violent incidents, and it is relatively straightforward to imagine that as venues target more and more specific groups of drinkers, some venues will focus on providing particularly masculine drinking places. Gruenewald's theory is supported by the finding that particular problematic venues are responsible for the vast majority of alcohol-related violence (312, 313), but is otherwise yet to be empirically tested.

One limitation of much of the theoretical work undertaken in this area has been the lack of focus on what specific theoretical explanations would mean for the kinds of empirical relationships expected between alcohol outlet density and violence rates. A concrete way of developing a better understanding of the nature of the link between alcohol outlet density and violence is to focus on the shape of any empirical relationship found between them. Broadly speaking, the effects of outlet density on violence can be separated conceptually into: (i) a proximity effect (how easily one can access alcohol); and (ii) an amenity effect (how outlets influence the quality and characteristics of surrounds within the local community). The proximity effect focuses on the impact of outlet density on the convenience of accessing alcohol, while the amenity effect stems from the criminologically focused explanations discussed above. Simple availability theory is largely concerned with the proximity effect: increased outlet density—whether for on-premise or off-premise sales—makes alcohol more accessible (each new store makes someone closer to a liquor store), consequently increasing consumption and alcohol-related problems. The amenity effect relates to the negative effects of licensed premises on the neighbourhoods in which they operate (and possibly adjacent neighbourhoods). From this perspective, alcohol outlets are seen as attractors of trouble, particularly violence, which might or might not have happened elsewhere. This may involve increased alcohol consumption overall, but it may also involve a simple redistribution of where consumption takes place. Both on- and off-premise outlets may have an amenity effect, in terms of who they attract and how they behave. The amenity effect of bunches of

alcohol outlets in the same district often results from crowds of young people, in various stages of intoxication, moving between outlets or spilling out onto the streets at closing time.

These two different aspects of density of alcohol outlets have different implications for the relationship between outlet density and alcohol-related problems. A proximity effect for alcohol outlets may operate in a similar way to the ‘retail gravity model’, whereby the effect of a new outlet declines with the square of the distance to the outlet. Norström (314) has demonstrated the applicability of this model to alcohol purchases, finding the effect of the availability of cheaper alcohol in Denmark on Swedish drinking diminished with the square of the distance from the main gateway between the two countries. If a similar effect were to exist for outlet density on consumption, the impact of extra outlets would diminish as the number of outlets per square kilometre increased. The nature of the amenity effect of outlet density is less clear. If each additional outlet attracts the same amount of additional problems, a straightforward linear relationship is plausible (at least until such time as the number of outlets reaches the maximum the market can support). However, addition of outlets in bunches may create a different effect. At a certain point, a growing bunch of outlets, particularly on-premise outlets such as hotels and bars, becomes fixed in people’s mental maps as an entertainment district, and thus starts attracting crowds above and beyond what would be attracted by the same number of outlets on their own. In this situation, there are likely to be large numbers of people circulating from outlet to outlet, creating the potential for additional alcohol-related problems. Thus, it is possible that the amenity effect of outlet density on alcohol-related problems has a critical point—the point at which an area is seen as an entertainment district—after which alcohol-related trouble increases more sharply with extra outlets.

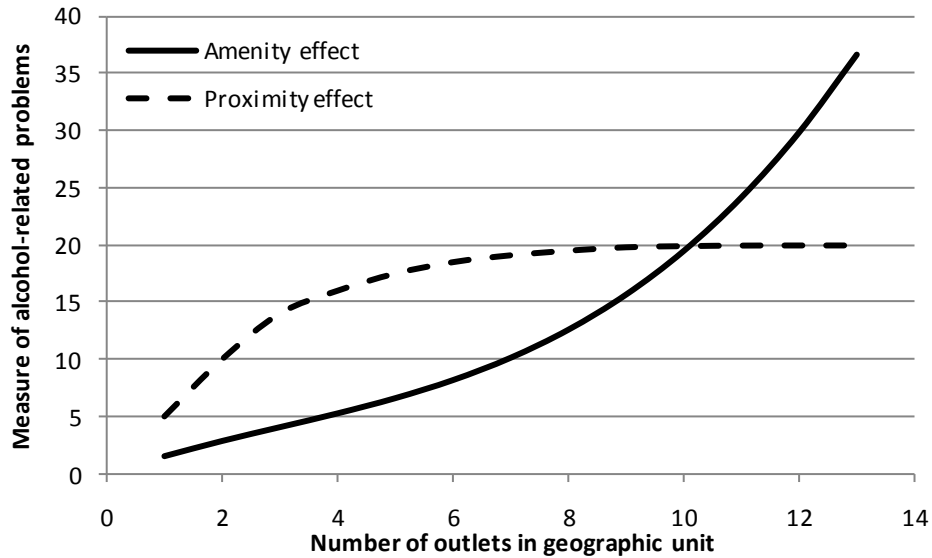


Figure 9 – Theoretical relationships between outlet numbers and alcohol-related problems, based on a proximity effect of outlets and an amenity effect

The potential shape of the relationships between outlet density and problems driven by these respective effects is presented in Figure 9. The proximity effect declines with increasing number of outlets so that, where there are large numbers of outlets in operation, the incremental impact of an extra outlet will be relatively small. In contrast, the potential impacts of the amenity effect of outlet density increase more sharply in areas of high existing outlet density. Analyses which examine the potential non-linearity of the relationships between outlet density and violence will provide some way of assessing the plausibility of these two kinds of theoretical relationships.

Empirical findings

Three robust longitudinal analyses of the relationship between alcohol outlet density and general violence have been published, with one using data at a national level (110), one relying on a natural experiment that saw a sharp reduction in outlet numbers (123) and just a single study making use of the ‘natural’ year to year changes in alcohol outlet numbers (122)¹⁸. Each of these studies found significant longitudinal associations between outlet density and violence, although their varying approaches and data sources make overarching conclusions difficult. Norström only included bar density in his time-series modelling,

¹⁸ Note that studies examining partner violence specifically have been excluded from the discussion in this chapter as they are dealt with in the subsequent chapter.

finding it significantly related to police records of assault over a thirty-five year period (110). In contrast, Yu et al. were limited to studying the effects of changes in off-premise outlet density following the destruction of large number of takeaway outlets during the civil unrest in Los Angeles in 1992 (123). Only Gruenewald et al. have undertaken a longitudinal study of outlet density and violence incorporating a range of outlet types, finding roughly equal positive relationships between bar and off-premise outlet density and assault-related hospitalisations (122).

In addition to these longitudinal studies, a series of cross-sectional analyses using small area data have been undertaken. These studies, largely from urban areas of the U.S., have focused on the cross-sectional associations between violence and alcohol outlets in small areas such as census tracts, while adjusting for a series of socioeconomic and demographic factors. The results of these studies have almost uniformly suggested significant positive relationships between outlet density and violence (69, 72, 75, 78, 80, 106-109, 111-120, 124-127, 315-319), with units of analysis varying from cities down to street blocks. The results of the one study that found no relationship between outlet density and violence at the city level in New Jersey (108) were later explained as an artefact of the geographic units used (109). A handful of studies from outside the U.S. have also found positive relationships between outlet density and violence (127, 199). Despite the broadly consistent results found in these studies, the specifics of the relationships between outlet density and violence have varied substantially. The effect of specific outlet types has been variable, with bars (114), off-premise outlets (111) and both types (sometimes in differing ways) (80, 115) significant in various studies.

Contextual effects

A key policy consideration that has seldom been addressed in the empirical literature is the potential interactions between outlet effects and other neighbourhood characteristics. When the interactions between outlet density and neighbourhood disadvantage have been studied, the results have also varied. Smith et al. (70) found that the relationship between outlets and violence was stronger in socially disorganised areas, while Nielsen and Martinez (115) found no significant interaction and Gruenewald et al. (80) found that bars were related to violence in unstable, poor areas *and* in rural middle-income areas, but not otherwise. A recent study using detailed land-use data from Cincinnati found significant interactions between land-use and outlet density effects, with bars more problematic in predominantly commercial areas and off-premise outlets more problematic in industrial areas or those with significant levels of

public housing (318). Some studies have examined how the characteristics of surrounding areas affect violence in the target area using spatially lagged data (e.g. the average outlet density in neighbouring areas), with varying results. Gorman et al. (78) found that outlets in surrounding areas were not related to violence in the target area, while Zhu et al. (116) found that spatially lagged outlet density was positively related to violence. In addition, studies that have focused on population characteristics of surrounding areas have found powerful effects for population density (80, 166).

Outlet density control policies and non-linear outlet density effects

As discussed earlier, the specific shape of the relationship between outlet density and violence is a key consideration for the development of robust theoretical explanations for the empirical findings discussed above. In addition, any non-linearities in the relationship have critical implications for policy. One potential policy response to the findings of the studies that draw a link between alcohol outlet densities and violence rates is the application of local limits on outlet density to minimise the associated problems. The obvious question raised by these kinds of policies is how to determine outlet density limits for a particular region. If the relationships between alcohol outlet density and harms are strictly linear, then the decision is simply a matter of weighing up predicted levels of alcohol-related harm with the benefits of alcohol outlets, as each extra outlet contributes the same increase in harms. On the other hand, if the relationship is non-linear, there may be more obvious threshold points, after which increases in alcohol outlet density lead to marked increases in associated harms, or saturation points, where any further increases have less or no effect.

Few studies have explored whether the effect of alcohol outlet density on violence is a linear one. An Australian study examining neighbourhood disorder rather than violence (121) used a categorical variable for outlet density, finding that the effect of outlets on alcohol-related problems was non-linear, with problems increasing more steeply at higher outlet densities. In a more rigorous examination of non-linearity, Gyimah-Brempong and Racine (320) used a non-parametric method to determine the best specification of the relationship between outlet density and crime at the census tract level in an unnamed U.S. city, finding non-linear relationships, with the expected increase in crime for each additional licence rising as the number of licences increased.

The current studies

The remainder of this chapter will be taken up with the presentation of two empirical studies, both based on postcode-level data from the Greater Melbourne area. The first uses cross-sectional data from 2001 and develops models exploring non-linear relationships between outlet density and violence, interactions between outlet density and socio-economic disadvantage and the effect of spatially lagged outlet density on rates of police-recorded assaults. The second study uses longitudinal data from 1996 to 2005 to explore whether there is a relationship between outlet density and violence rates over time. In addition, this longitudinal analysis is then replicated for five distinct categories of community, to determine whether particular types of outlets are more or less associated with assault rates in different types of neighbourhood. These two studies will be presented sequentially and then the implications of their findings will be discussed.

5.2 Cross-sectional analysis of outlet density and assault

Methods

Aggregated administrative data was used to assess whether the number of active liquor licences was related to police recorded assaults when a range of neighbourhood characteristics were controlled. The analysis was undertaken using data from 2001, ensuring demographic data from the 2001 national census could be used without inconsistencies in the study timeframe.

Geographical units

The study used postcode-level data for the Greater Melbourne area, as outlined in Chapter 2. Assault rates and outlet densities were calculated for each postcode on a population basis as rates per 1,000 residents. Some previous studies have used roadway miles to denominate their measures (e.g. 80), but the use of alternative measures such as land area or population as denominators have resulted in similar findings (75). In addition to the two postcodes (i.e. an airport and a military base) that were excluded from all analyses in this thesis, initial analyses highlighted three outliers (central postcodes with high outlet and assault numbers and very

low resident populations) that were excluded from the regression models. With these five units excluded, the final analyses were undertaken using 217 postcodes¹⁹.

Licensing data

The licensing data used in this chapter have been discussed in detail in Chapter 2 and will only be briefly summarised here. Three types of licences are examined: general, on-premise and packaged. These three licence categories made up more than three-quarters of the licences in Victoria in 2001. General licences allow the licensee to sell alcohol for consumption both on and off the premises, and apply to taverns, hotels and pubs. On-premise licences allow the licensee to sell alcohol on the premises only, and generally apply to restaurants, bars and nightclubs. Packaged licences allow alcohol to be sold for off-premise consumption only and apply to retail liquor stores (including some supermarkets). The models in this section include densities for all three of the licence categories. Separate models were developed including only one category at a time, with broadly similar results.

Assault data

Assault data were provided by the Victorian Police from their Law Enforcement Assistance Program (LEAP) database. Due to the lack of a reliable indicator of alcohol involvement in the police data, assaults taking place between 8pm and 6am on Friday and Saturday were considered ‘alcohol-related’ (223). Thus the term ‘alcohol-related assaults’ in this chapter refers to assaults that took place between these times. It should be noted that these data may be influenced by policing practices, and that it was not possible to assess the validity of police recording of postcode data. However, it is expected that these influences will be minor and that police-recorded assault data provide a reasonable basis for analysing postcode-level rates of violence. Alcohol-related assault rates were calculated on a per 1,000 population basis. To ensure that the rates used were stable, the average assault rates over three years (1999/00 – 2001/02) were calculated and used as the study outcome variable.

Census data

Data from the 2001 Australian Census of Population and Housing were used for a range of socio-demographic variables in this study. Postcode level socio-economic status was

¹⁹ Note that this is more postcodes than are used in subsequent longitudinal analyses, which are based on 186 postcodes with consistent boundaries over time.

measured using a composite measure, the Index of Relative Socio-Economic Disadvantage (IRSED) (286) derived from census data. The other census variables used were: the number of people counted in the area; the percentage of the population male and aged between 15 and 34 (the population subgroup most involved in assaults); population per square kilometre; average number of people per household; percentage of the population that had moved house in the previous year; percentage of the population that spoke a language other than English at home; and the percentage of the population counted in the postcode who were not usual residents (as a proxy for tourist activity). Two other variables (the percentage of households that were owner-occupied; the percentage of the population who were born overseas) were considered, but were excluded from the final analysis as they were highly correlated with the other socio-demographic measures used and resulted in multicollinearity in initial regression models.

Analyses

All statistical analyses were undertaken using the R software package (288), with the ‘spdep’ package (321) used for spatial analyses.

The dependent variable for this study was the three-year average of the rate of alcohol-related assaults. The independent variables were the outlet densities for each of the three licence types, the population density, the IRSED index and the Census-derived variables listed above. Using these variables, a series of multiple regression models were developed.

The initial model included only linear effects for each independent term. This model was then expanded in three ways. Firstly, cubic polynomial terms for the significant outlet density variables were included in a multiple regression model. An initial quadratic model was also fitted, but it was significantly poorer than the cubic model and is not presented here. This modelling approach provides an opportunity to explore whether the impact of outlets on alcohol-related assaults is steady (i.e. each extra outlet has the same effect on the alcohol-related assault rate) or whether there are non-linearities in the relationship, suggesting densities beyond which extra outlets have either little impact or a more pronounced impact on violence. Secondly, interaction effects between outlet densities and the IRSED indicator were included to assess whether outlet density was differentially related to assaults in neighbourhoods of differing levels of socio-economic disadvantage. Finally, a model

incorporating spatial lags was developed, to assess whether the characteristics of neighbouring postcodes were related to the assault rate in the target postcode.

In order to assess whether the final models were biased due to the lack of independence of the geographic units, each of these models was examined for evidence of spatial autocorrelation (see (166) for a good discussion of spatial autocorrelation in outlet density studies). In each case, the Moran Coefficient (M.C.) was non-significant, precluding the need for more sophisticated spatial error models. Despite the non-significant M.C., generalised least squares models incorporating spatial error terms were developed to ensure spatial autocorrelation was not influencing the study's results. These models did not produce markedly different results from the regular OLS models presented in this chapter. Finally, the four fitted models were compared, to ascertain which provided the best explanation of the observed data.

Results

The zero order correlations between the dependent variables and the alcohol related assault rate provided in Table 8 demonstrate that without other control variables, each measure of outlet density is positively associated with the alcohol-related assault rate.

Table 8 - Descriptive statistics of measures used in analysis

Variable	Min	Max	Mean	SD	Correlation with alcohol-related assault rate
Alcohol-related assault rate	0.0	4.4	0.6	0.7	n.a.
General licence density	0.0	3.3	0.1	0.3	0.65**
On Premise licence density	0.0	10.9	0.5	0.9	0.57**
Packaged licence density	0.0	1.5	0.2	0.3	0.17*
IRSED index of disadvantage	707.0	1152.0	1048.0	1034.0	-0.02
% Males aged 15-34	10.2	34.3	14.3	15.0	0.26
Population density	5.6	6405.0	1593.0	1637.0	0.19**
% Moved in the last year	5.9	41.8	14.8	16.2	0.47**
Average household size	1.7	3.7	2.7	2.7	-0.38**
% Non-English speaking background	1.8	77.1	20.0	24.0	0.05
% counted in postcode who were not usual residents (tourism)	0.0	22.1	0.8	1.3	0.69**

* Significant at the 0.05 level. ** Significant at the 0.01 level.

The results of the four regression analyses are presented in Table 9, Models 1-4. Model 1 includes linear effects for each of the outlet density measures and socio-demographic factors, Model 2 includes cubic polynomial functions for each of the three outlet density measures, with linear, quadratic and cubic terms, Model 3 incorporates interaction terms between socio-economic disadvantage and outlet density and Model 4 incorporates spatially lagged measures for each of the outlet density measures, the IRSED measure of socio-economic disadvantage and population density. The results for the socio-demographic factors are consistent across the four models, with socio-economic disadvantage positively related to violence rates and household size, while the percentage of the population from non-English speaking backgrounds is negatively related to violence.

The results for the outlet density measures varied slightly depending on the model specification, although it is clear across all models that general and on-premise outlets were much more relevant than packaged outlets. In Model 1, both general and on-premise outlet densities were positively related to assault rates, while there was no significant effect for packaged outlet density. In Model 2, there were significant non-linear effects for general and packaged outlet densities and a positive, linear effect for on-premise density. General licence density remained positively associated with violence in Model 3, while effects for on-premise and packaged densities and all interaction terms were non-significant. In Model 4, both general and on-premise densities were related to assault rates, but only for local densities, while there was a negative effect for the spatially lagged density of packaged licences.

The four models produced were compared using the Akaike Information Criterion (AIC), which measures the goodness of fit of regression models, with a penalty for increasing the number of parameters that are estimated (322). Lower values of the AIC represent models that use the fewest parameters possible to best fit the data. The AIC values for the models fitted in this study are provided in Table 10. Clearly, Model 2, incorporating non-linear effects for outlet densities, is the best fit to the data. Thus, the remainder of this section will focus on Model 2, and particularly on the implications of the non-linear terms for the outlet density measures. It should be noted that standard regression diagnostics were run on all models, with no problems identified.

Table 9 - Regression models of alcohol-related assaults

Variable	Model 1 – Basic model			Model 2 – non-linear density effects			Model 3 – interaction between density and deprivation			Model 4 – lagged effects		
	Parameter estimate	Std. Error	Signif.	Parameter estimate	Std. Error	Signif.	Parameter estimate	Std. Error	Signif.	Parameter estimate	Std. Error	Signif.
Constant	5.26	0.77	<0.01**	4.83	0.76	<0.01**	6.06	1.02	<0.01**	5.33	0.99	<0.01**
General licence density	0.41	0.08	<0.01**	0.84	0.31	0.01*	2.44	1.10	0.03*	0.41	0.09	<0.01**
On Premise licence density	0.17	0.03	<0.01**	0.27	0.10	0.01*	-0.53	0.47	0.26	0.16	0.03	<0.01**
Packaged licence density	-0.23	0.14	0.11	0.89	0.63	0.16	-3.15	2.18	0.15	-0.24	0.15	0.10
IRSED index (lower = more disadvantage)	-0.01	<0.01	<0.01**	-0.01	<0.01	<0.01**	-0.01	<0.01	<0.01**	-0.01	<0.01	<0.01**
Population per square kilometre	<0.01	<0.01	0.25	<0.01	<0.01	0.21	<0.01	<0.01	0.42	<0.01	<0.01	0.81
Average household size	-0.33	0.14	0.02*	-0.22	0.15	0.13	-0.36	0.15	0.02*	-0.35	0.16	0.03*
% of population that were males aged 15-35	0.01	0.02	0.75	0.01	0.02	0.52	0.01	0.02	0.66	0.01	0.02	0.68
% of population that had moved in last year	-0.01	0.01	0.49	-0.01	0.01	0.35	-0.01	0.01	0.41	-0.01	0.01	0.27
% Non-English speaking background	-0.01	0.01	<0.01**	-0.01	0.01	<0.01**	-0.01	<0.01	<0.01**	-0.01	0.01	<0.01**
% in postcode who were not usual residents	-0.03	0.02	0.16	-0.02	0.02	0.38	-0.03	0.02	0.11	-0.04	0.02	0.05
(General licence density) ²				-0.85	0.31	0.01**						
(General licence density) ³				0.25	0.08	<0.01**						
(On Premise licence density) ²				0.01	0.03	0.89						
(On Premise licence density) ³				-0.01	<0.01	0.27						
(Packaged licence density) ²				-2.65	1.32	0.05*						
(Packaged licence density) ³				1.33	0.67	0.06						
IRSED * General licence density							-0.02	0.01	0.07			
IRSED * On Premise licence density							0.03	0.02	0.18			
IRSED * Packaged licence density							0.01	0.01	0.14			
Lag (General licence density)										-0.002	0.171	0.99
Lag (On Premise licence density)										0.102	0.064	0.11
Lag (Packaged licence density)										-0.656	0.312	0.04*
Lag (IRSED)										0.001	0.001	0.57
Lag (Population per square kilometre)										<0.001	<0.00	0.58
Adjusted R-squared	0.58			0.62			0.58			0.59		
Moran's Coefficient	-0.02		0.91	-0.04		0.66	-0.03		0.83	-0.02		0.99

* Significant at 0.05 level. ** Significant at 0.01 level.

Table 10 - Akaike Information Criterion (AIC) for model comparison, lower AIC indicates better fit

<i>Model</i>	<i>AIC</i>
Model 1 (Linear, main effects)	274.5
Model 2 (Non-linear)	258.9
Model 3 (Interaction terms)	276.0
Model 4 (Lagged terms)	274.8

Comparing non-linear and linear relationships between outlet density and assault

The final model (Model 2) includes cubic polynomial terms for each outlet density measure. This formulation allows the relationship between outlet density and alcohol-related assault rate to vary, so that the effect of an extra outlet is not fixed. That is, the effect on the assault rate in a particular postcode of changing the number of outlets from two to three, may not be the same as the effect of changing the number of outlets from twenty to twenty-one. This is demonstrated in Figure 10, Figure 11 and Figure 12, which illustrate the relationship between alcohol outlets (general, on-premise and packaged respectively) and alcohol-related assaults in a hypothetical community. All the characteristics of this illustrative community, except for the particular outlet type being examined, have been set to the median values in the sample and multiplied by the regression coefficients to provide model-based predictions for assault numbers. Thus, in Figure 10, the hypothetical community has the number of on-premise and packaged outlets specified by the median on-premise and packaged densities, while the effect of general licence density is plotted between the minimum and maximum rates found in the data. In Figure 11, everything is fixed at median levels except for on-premise outlet density, and for Figure 12, only packaged outlet density varies. The number of alcohol-related assaults in the postcode predicted by Model 1 (linear) and Model 2 (non-linear) are both included to demonstrate the benefits of considering non-linear relationships compared with the standard linear relationships.

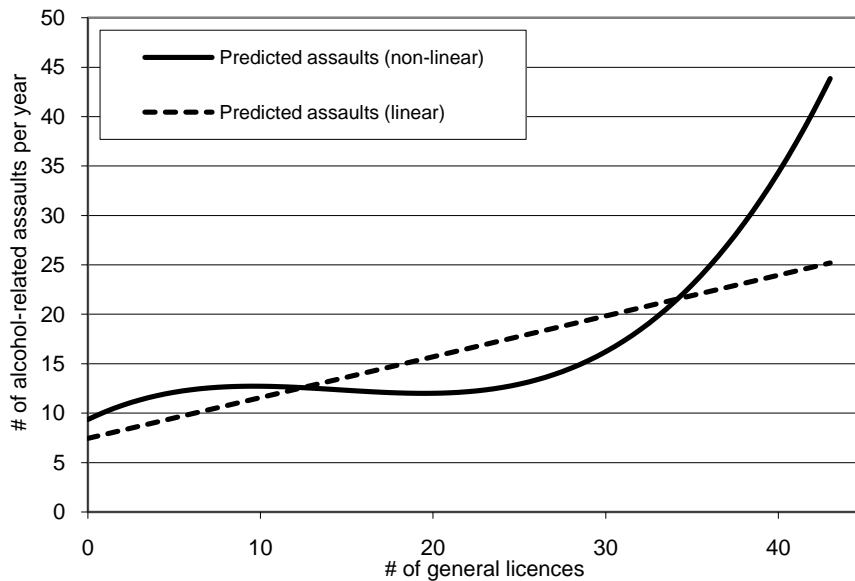


Figure 10 – Application of the results of linear and non-linear models of the association between general licences and alcohol-related assaults in a hypothetical postcode

As presented in Figure 10, the linear model of the relationship between general outlets and violence shows that as the number of general licences in this postcode increases from zero to 42, the predicted annual number of alcohol-related assaults increases steadily from seven to 25. The non-linear model, on the other hand, shows little difference in the number of assaults expected between zero and 25 licences (around twelve), and a sharp increase between thirty and 42. This more complex relationship provides some indication of a crucial threshold level of general licences for the postcode (around thirty), above which each new licence results in a marked increase in the expected number of alcohol-related assaults.

The non-significance of the non-linear terms for on-premise outlet density is clearly illustrated in Figure 11, with the minimal differences between the linear relationship from Model 1 and the non-linear relationship from Model 2.

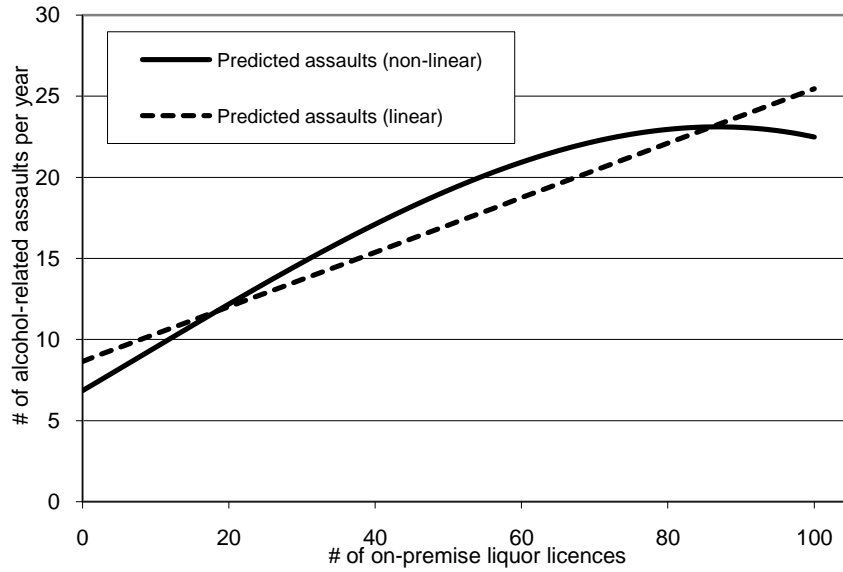


Figure 11 - Application of the results of linear and non-linear models of the association between on-premise outlet and alcohol-related assaults in a hypothetical postcode

The linear relationship between packaged liquor outlets and alcohol-related assaults is negative (but non-significant), while the borderline-significant non-linear relationship from Model 3 shows a similar, if slightly steeper, decline until the number of outlets gets to fifteen, after which each extra outlet results in a sharp increase in the predicted number of assaults (Figure 12). It is not clear that this represents a genuine effect, as the coefficients are only marginally significant.

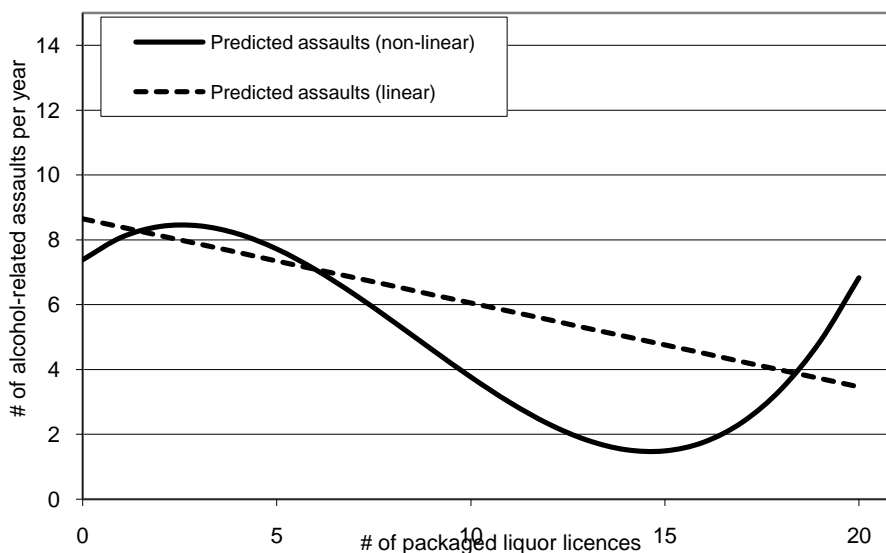


Figure 12 - Application of the results of linear and non-linear models of the association between packaged licences and alcohol-related assaults in a hypothetical postcode

Discussion

The results of this study provide further evidence of a cross-sectional link between alcohol outlet densities and violence. The study examined the relationship between the density of three types of outlets, general (hotels and taverns), on-premise (restaurants, bars and nightclubs) and packaged (retail outlets) and alcohol-related assault rates. The best model (Model 2) included non-linear relationships between some outlet densities and assault, suggesting that the effect of outlet density on violence differs depending on the pre-existing level of outlet density. This model was a substantial improvement on the basic linear model, and the implications of the non-linear outlet density effects for determining plausible outlet limits were examined for a hypothetical community.

The broadly positive relationship between density of general licence premises and assaults is not surprising. Previous studies have found that tavern and bar densities are related to violence (e.g. 69, 122), and studies in settings where licences combine on- and off-premise consumption have also found significant links between outlet density and violence (78, 118). The non-linearity in the relationship between general licences and alcohol-related assaults in this study provides evidence that, while the overall relationship is positive, with alcohol-related assaults increasing with the number of outlets, there may be a point after which each additional outlet contributes increasing numbers of additional assaults. Given the nature of the licensing data used for this study, it is impossible to fully determine whether the assaults associated with general licence density are related to on- or off-premise consumption. However, with the assault measure used in this study (assaults recorded by police between 8pm and 6am on Friday and Saturday), it seems reasonable to assume that a substantial proportion of the assaults are related to on-premise consumption, as these times represent the peak times for customers frequenting on-premise drinking establishments.

Regarding on-premise licences, only the linear term was significant in the final model, suggesting a fairly simple relationship between on-premise outlet density and alcohol-related assault rates. This relationship is similar to many results found for density of bars in other settings (114, 115). In addition, the work undertaken by Smith et al. (70) combined restaurants and bars into a single index (providing a comparable metric to the on-premise licences as defined in Victoria) and found a significant positive relationship between this index and street robberies. Contrastingly, Zhu et al. (116) found a negative relationship

between restaurant density and violence, while finding a positive link with bar density. The nature of liquor licensing in Victoria makes replication of their work impossible, with data for on-premise licences on the licensing database not easily disaggregated into restaurant and bar sub-categories.

The differing relationships for general and on-premise licences require further examination. General licences are provided for the drinking establishments traditionally termed ‘pubs’ or ‘hotels’ in Australia, while on-premise licences cover a wide array of other drinking establishments including restaurants, bars, cafes and nightclubs. In general, a hotel is a place that patrons visit for the specific purpose of drinking alcohol and previous Australian work has highlighted hotels as particularly problematic premises in terms of violence (312). The on-premise licence category includes a wide array of premises including places where drinking alcohol is not the primary focus of patrons (e.g. restaurants, cafes). It is conceivable that the relationship found between general licences and violence would be similar for the subset of premises within the on-premise licence category where drinking is the main activity (e.g. nightclubs), however this cannot be tested with the current data.

Packaged outlet density has been repeatedly linked with violence in the U.S. studies (80, 107, 111), and the lack of a clear positive relationship in this study was surprising. The non-linear relationship found in the final model suggests a possible positive relationship between packaged outlet density and violence when packaged outlet density is high (see Figure 12), but the effect is only marginally statistically significant. It is difficult to compare the results of this study with previous work examining off-premise outlet density and violence. For example, it is conceivable that the definition of alcohol-related assaults used for this study focused the analysis on assaults more likely to be related to on-premise consumption. However, it is also worth noting the cultural differences between the use of packaged liquor outlets in Melbourne and those in some of the other study sites. In the U.S., off-premise outlets have been suggested as hubs for a range of other violence-related activities. In particular, Alaniz et al. (107) discuss the relationship between drug use, gang activity and other risky behaviours and liquor outlets, while other authors (157) have pointed to the sale of drug paraphernalia by packaged outlets in California as an indication of their role as attractors of problem behaviours. These associations have not been examined in Australian studies, but

these problems don't appear to be strongly linked with packaged liquor outlets in an Australian context.

Only two of the non-outlet factors examined were consistently significant. A negative relationship between socio-economic status and rates of violence was found across all four model specifications, consistent with the substantial research literature highlighting the relationship between neighbourhood deprivation and violence (71, 309). The consistently significant negative relationship identified between the proportion of the population speaking a language other than English and rates of alcohol-related violence has little precedent in the literature, but is likely to reflect the lower drinking rates of some non-English speaking immigrant groups in Australia (188).

While this study provides good evidence of a spatial association between alcohol-related assaults and alcohol outlet density, it should be noted that its cross-sectional design prevents strong conclusions being drawn around causality. Furthermore, previous work (312) has highlighted that assaults on licensed premises disproportionately take place in a small number of establishments, highlighting the need to further examine the types of outlets that are related to assaults. Further data, such as alcohol sales, opening hours, capacity and venue style could provide substantial insights into how different outlets contribute to the effect of outlet density on assault.

This study has shown a significant positive relationship between alcohol outlet density and assault rates. In particular, the examination of non-linear effects of outlet density suggested a critical threshold for general licence density, after which rates of violence increase sharply. This effect requires further examination, but suggests that alcohol-related problems don't necessarily increase consistently with outlet density and provides an avenue for the development of empirically-derived caps on liquor licences in local areas, an avenue that is increasingly being examined by local governments in Australia. The overall positive link between outlet density and violence found in this study provides more evidence that the ongoing liberalisation of liquor licensing policy in Australia, in part driven by the National Competition Policy (23, 323), has the potential to result in significant increases in public order and public health problems.

5.3 A longitudinal analysis of the relationship between alcohol outlet density and assault

The analyses above contribute to the substantial cross-sectional literature that has demonstrated links between alcohol outlet density and violence. This cross-sectional literature is made up of analyses at a particular point in time of local-area rates of violence and outlet density, with appropriate socio-demographic controls. While such studies generally show that violence tends to be located in areas with high numbers of alcohol outlets, they cannot demonstrate what happens in a particular area when the number of outlets changes. This longitudinal relationship is a key concern for policy, as changes to licensing policy imply changes to alcohol outlet density across time. However, as discussed earlier in this chapter, there is only a limited literature that has examined this question. Furthermore, the two small area studies that exist have both relied on data from California, making analyses from different settings crucial.

For these reasons, a longitudinal study was undertaken of the relationship between alcohol outlet densities and rates of alcohol-related violence at the postcode level in Melbourne, Australia from 1996 to 2005, using panel data methods. In addition to providing a rare longitudinal examination of these relationships, the study is unique in that it focuses on the types of region in which outlet density and violence are related, to try to develop a better idea of the kind of neighbourhoods in which alcohol outlets are particularly problematic. The results of the cross-sectional analysis in the previous section provided no indication of a moderating effect of socio-economic disadvantage on the relationship between alcohol outlet density and violence (i.e. the interactions of the IRSED index and outlet densities were all non-significant). However, the approach taken previously was relatively simplistic, focussing only on potential interactions between socio-economic status and outlet effects. To extend this, the analyses presented below take a more nuanced approach to exploring contextual effects, looking beyond merely socio-economic disadvantage. While the findings of the previous section suggested some non-linear relationships between outlet density and violence, the limited timeframe available for the current study does not provide sufficient power to examine non-linear effects longitudinally. Thus, the analyses presented below will use a simple linear statistical approach.

Methods

Aggregate data on liquor outlets and police-recorded night-time assaults were used to assess whether changes in outlet density over recent years have produced corresponding changes in rates of assault. The analysis was undertaken using data from 1996 through to 2005. The study units were the 186 postcodes from the greater Melbourne region that had not had boundary changes over the timeframe concerned, as discussed in Section 2.2. The licensing data used were the same as have been discussed previously, with annual counts of outlets based on licences active as at June 30 each year. As with the previous section, the outcome variable examined was based on the number of assaults taking place between 8pm and 6am on Friday and Saturday nights²⁰.

Population and Census data

The postcode population data were based on census data from 1996 and 2001 (324) as well as Estimated Residential Population figures for 2005 and 2006 (218). Population data for 1997-2000 and 2002-2004 were linear interpolations. While these population data are thus estimates, they are likely to be consistent with the actual annual changes.

Detailed socio-demographic data were not available at the postcode level for each year of the study. Thus, the models developed here do not control for changes in socio-demographic factors (e.g. unemployment rates etc). The socio-demographic data used to cluster postcodes into groups with similar characteristics was extracted from the Basic Community Profiles provided from the 2001 Census of Population and Housing (324). The variables used in the clustering process were chosen based on previous studies assessing the relationship between outlet density and violence, and focussed on socio-economic disadvantage, population density and ethnicity. These items are described in full below.

Using numbers rather than rates

Generally speaking, analyses of the relationship between outlet density and violence, including previous work on the data used here, have used per-capita rates for both the outlet

²⁰ Analyses were also undertaken using all assaults rather than just night-time assaults. The results were broadly similar, although effect-sizes were smaller, suggesting the effect of outlets on violence is predominantly on violence within these high alcohol hours

density and violence measures, and the original intention was to continue to use them for this study. However, there are some problems with the use of per-capita rates for both outlet density and violence, which are particularly clear when data are explored over time. A per-capita crime rate for region 'a' is simply calculated as: $R_a = C_a/P_a$. Where R_a is the rate in region 'a', C_a is number of the crimes that took place in region 'a' (over a particular time period) and P_a is the resident population of region 'a'. For this definition to be meaningful, P_a should represent the number of potential victims or offenders in region 'a' (325). However, this is not always the case. In particular, when the data being examined are for small areas (such as postcodes), there is likely to be substantial differences between the resident population and the actual number of people within an area at risk of victimisation. This effect is particularly noticeable for entertainment districts. For example, the City of Melbourne has an estimated residential population of approximately 60,000 people (326), while it is estimated that around 330,000 people visit the city at night for work or entertainment (327). This problem is exacerbated when examining changes in rates over time. For example, between 1996 and 2005, the number of assaults in the Melbourne Central Business District (CBD) (postcode 3000) increased from 848 to 932. However, because of a concurrent increase in inner-city residents, the assault rate actually fell, from 107 per 1,000 residents to just 62 per 1,000 residents.

These problems have been tackled in a number of ways in the existing literature. Some analyses have used 'service' populations, which take into account tourists and visitors to a region (211), although this method still relies on people spending the night in the region in question. Other studies have used roadway miles to denominate their rates, particularly when dealing with driving-related harms such as motor vehicle crashes (140). In general, the use of different denominators for outlet density measures have not had marked effects on results (75). Thus, we use the number of assaults and outlets in our models and include residential population as a predictor. This has the advantage of controlling for the effects of changes in population, without introducing the problems discussed above.

Analysis

The study is undertaken in two stages. In the first, a model of the impact of alcohol outlet density on violence across the entire study area is examined. In the second, the postcodes are grouped into clusters based on their socio-demographic characteristics and separate models

are developed for each cluster. This section first summarises the longitudinal modelling techniques used and then discusses the process used to derive postcode clusters.

Fixed effects modelling

The dependent variable in the regression analyses for this study was the number of alcohol-related assaults in each of 186 postcodes that were spatially consistent across the study period. The primary independent variables were the numbers of each of three types of liquor outlets and the resident populations of the postcodes. The focus of the study was the changes in assault and outlet numbers within postcodes over an eight-year period. Because the time-period under analysis was too short for traditional time-series modelling, it was necessary to develop cross-sectional time-series or panel models. Using these methods is basically equivalent to undertaking a series of short time-series analyses, with the replications across postcodes making up in statistical power for the shortness of the time-series. There are two main approaches to these analyses: fixed-effects and random-effects (328). This study develops fixed-effects models, which are asymptotically consistent and appropriate for situations where the units analysed are not a random sample from a larger population. In addition, fixed-effects models focus on maximising the explained variance within units, reducing the possibility that cross-sectional differences between units will bias the results. Random-effects models are more efficient estimators, but are also more susceptible to finding significant effects based on cross-sectional differences rather than changes over time. Generally, if a Hausman test comparing fixed and random-effects models is not significant, the more efficient random-effects model is used (329). However, in this study, the parameters from all the fixed-effects models were significantly different ($p < 0.05$) from the equivalent random-effects models, and so fixed-effects models were used. To ensure that city-wide trends did not influence the results, statistical controls for the overall effect of each year (10 *df*) were included.

As discussed earlier, analyses of spatial units can result in a violation of unit independence, a key assumption of regression models. Thus, the fixed-effects models developed in this study included controls for spatial autocorrelation to ensure unbiased estimates were produced. These models were developed using the Matlab spatial econometrics toolbox developed by Paul Elhorst and described in detail in Elhorst (204).

Clustering of postcodes

Clusters were developed using the two-step cluster analysis technique in SPSS, with a log-likelihood distance measure, a distance metric used when the variables being used to develop clusters include both continuous and categorical variables. The final number of clusters was determined using Schwarz's Bayesian Information Criterion (330). Postcodes were grouped together based on:

- Population
- Area
- SEIFA index of relative socioeconomic disadvantage (IRSED) (low score = more disadvantage) (286)
- % of residents in public housing
- % of residents born overseas
- % of residents who had moved house in the last 5 years (to measure residential mobility)
- % of residents who identify as Indigenous
- % of people counted in the postcode who were not usual residents (to measure tourism)
- Population density
- Rate of on-premise outlets per 1,000 residents
- Rate of packaged licences per 1,000 residents
- Rate of general licences per 1,000 residents

This produced five postcode clusters. It should be noted that these clusters are not contiguous geographical clusters; instead they are based on socio-demographic characteristics of regions. Separate fixed-effects models were then developed for each of these clusters allowing inferences to be made regarding the relationship between outlet density and harms in particular types of postcode.

Thus, six final models were developed: one for the entire city and one for each of the five postcode clusters. To minimize the risk of Type 1 errors due to the number of tests being undertaken, alpha levels of 0.01 were used.

Results

The first model was developed for the entire region, with number of assaults as the dependent variable and each of the three outlet measures, the resident population and time-trend controls included as predictors. The results of this analysis are provided in Table 11. This broad model finds positive overall effects for all three licence types on violence. Spatial autocorrelation was positive and significant in the model.

Table 11 - Fixed effects model of the relationship between alcohol outlet numbers and alcohol-related assaults

Variable	β	t	p
Scaled population	0.52	16.80	<0.01
General licences	0.90	14.79	<0.01
Packaged licences	0.39	3.45	<0.01
On-premise licences	0.25	11.42	<0.01
Spatial autocorrelation	0.26	7.53	<0.01
Number of postcodes (N)	168		
Number of time points (T)	10		

Note: parameter estimates for the trend control variable have not been reproduced

The clustering of postcodes based on their socio-demographic data produced was undertaken as described in the methods section. The clustering procedure produced five distinct clusters of postcodes. A summary of the final clusters is provided in Table 12.

Table 12 - Description of postcode clusters used in analysis

Cluster	N (%)	Characteristics (based on variables described on previous page)	Examples
1	7 (3.8)	Central suburbs. High rates of overseas born residents, high public-housing, high tourism, small area, high population density, high mobility, high licence rates, moderate socio-economic status.	Central Business District, Southbank, Fitzroy
2	23 (12.4)	Inner-urban suburbs. High socio-economic status, high population density, high mobility, moderate tourism, moderate licence rates, high rates of overseas born residents.	Brunswick, Carlton North, Richmond
3	80 (43.0)	Advantaged-suburban. High population, high socio-economic status, moderate population density, moderate rates of overseas born residents.	Brighton, Toorak, Moonee Ponds
4	34 (18.3)	Fringe. Low population, v. low population density, high socio-economic status, low mobility, low rate of overseas born residents, low licence rates, low public housing	Keilor, Beaconsfield, Diamond Creek
5	42 (24.6)	Disadvantaged-suburban. High population, low socio-economic status, moderate population density, low mobility, high rate of overseas born residents, low tourism, moderate public housing, low licence rates	Craigieburn, Frankston, Footscray

The postcode clusters produced were meaningful groups, with, for example, cluster 1 containing the ‘entertainment districts’ of Melbourne. A map of Melbourne showing the distribution of these five clusters is presented below in Figure 13. It was expected that the effects of increasing or decreasing outlet density would vary between these five types of neighbourhood.

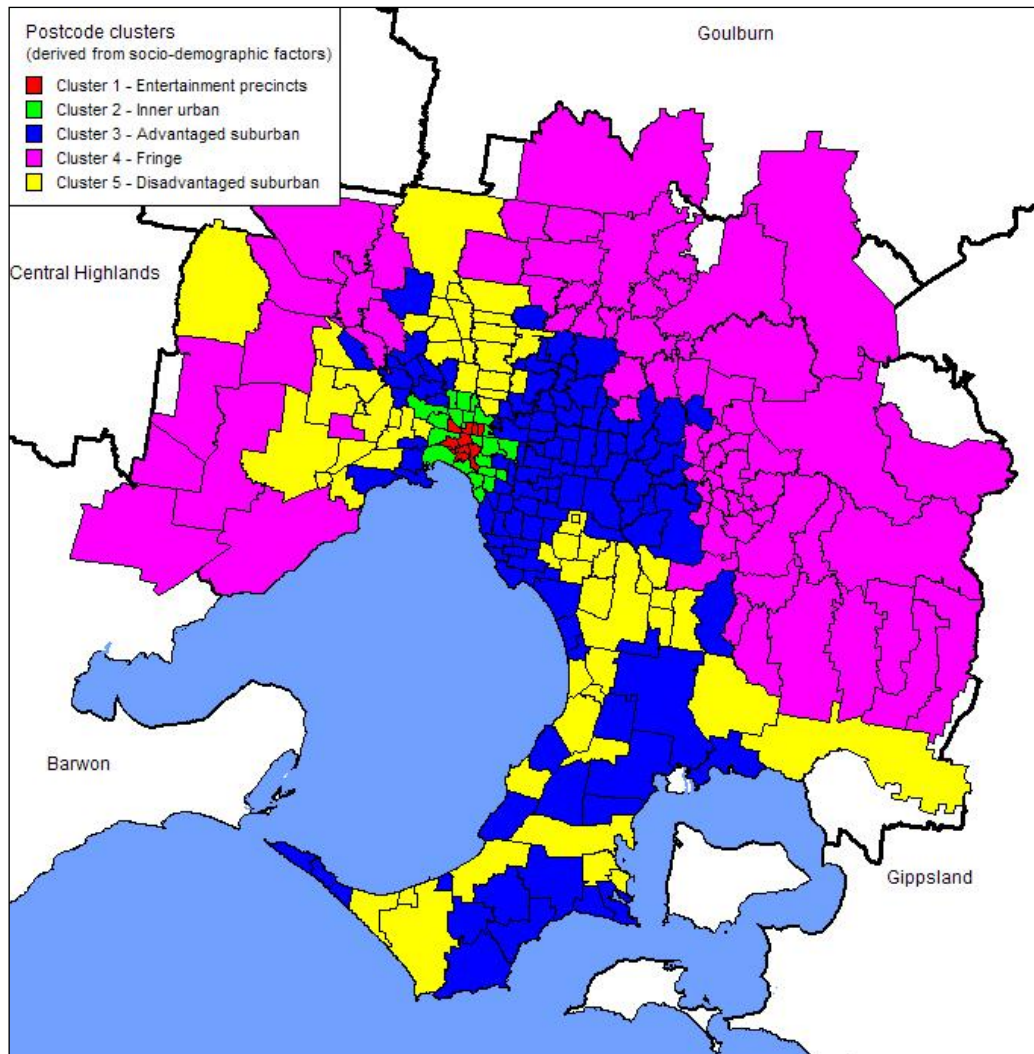


Figure 13 - Melbourne postcode clusters based on similar socio-demographic profiles

Having developed these clusters, five fixed-effects models were run to assess the relationship of outlets to assaults within each cluster. The results of these analyses are provided in Table 13.

The five models produced show some significant effect of outlets on violence in four of the five postcode clusters, with only the model for the fringe postcode cluster finding no significant outlet effect. General or hotel licences were significant in the central suburbs and the advantaged suburban areas, packaged licences in the advantaged and disadvantaged suburban clusters and on-premise (restaurants and nightclubs) were significant in inner-urban, advantaged suburban and disadvantaged suburban areas. Spatial auto-correlation was significant in all five models.

Table 13 - Fixed effects model of the relationship between alcohol outlet numbers and alcohol-related assaults, by postcode cluster

Variable	1 – Central suburbs			2 – Inner-urban suburbs			3 – Advantaged suburban			4 – Fringe			5 – Disadvantaged suburban		
	β	t	p	β	t	p	β	t	p	β	t	p	β	t	p
Scaled population	-8.31	-5.46	<0.01	0.59	5.13	<0.01	0.40	10.04	<0.01	0.73	10.15	<0.01	0.42	9.79	<0.01
General licences	2.04	8.00	<0.01	0.22	2.23	0.03	0.46	2.72	0.01	0.42	2.29	0.02	0.37	1.56	0.12
Packaged licences	-2.84	-1.70	0.09	-0.37	-1.31	0.19	0.51	4.02	<0.01	-0.21	-0.94	0.35	0.66	3.48	<0.01
On-premise licences	0.05	0.50	0.62	0.47	16.61	<0.01	0.20	4.95	<0.01	0.09	1.13	0.26	0.80	8.44	<0.01
Spatial autocorrelation	0.35	2.79	0.01	-0.50	-3.90	<0.01	0.26	5.79	<0.01	-0.03	-0.32	0.75	0.47	10.06	<0.01
Number of postcodes (N)	7			23			80			34			42		
Number of time points (T)	10			10			10			10			10		

Note: parameter estimates for the trend control variable have not been reproduced

Discussion

The results of the longitudinal analysis described provide additional evidence that changes in the number of alcohol outlets in a community are related to changes in the amount of violence experienced in that community. The results do not give clear indications that particular licence categories are more problematic than others, with each licence type examined related to violence in certain community types. This variety of effects suggests substantial differences in how different licence categories are being used in particular neighbourhoods. For example, it seems clear that hotel licences are a particular concern in the inner-city, while packaged liquor outlets are more problematic in suburban areas. In some ways, these effects are related to the kinds of licences that are typically in operation in certain types of areas. For example, almost half of general licences in 2005 were in cluster 1 postcodes, which made up only 7 of the 186 postcodes examined and contained less than 10% of the packaged licences in the study area. However it is also worth considering whether these different types of premises are used differently by people in different areas. For example, it is possible that packaged liquor outlets provide a place for people to meet and entertain themselves in suburban areas where fewer on-premise and hotel establishments are available. Similarly, the mix of nightclubs and restaurants in the on-premise licence category may vary substantially across the postcode clusters examined, resulting in different uses of the same licence categories. There has been no research into the geographic variation in the nature or use of alcohol outlets, so the precise mechanisms underlying these differential effects remain unclear and require further examination.

The overall effects found in this study reflect seemingly small impacts for alcohol outlets on violence. For example, the addition of an extra on-premise licence in the postcodes examined is estimated to result in an increase of 0.25 assaults per year, while the addition of a general licence is estimated to increase assaults by 0.90 per year and a packaged licence by 0.39 per year. While these effects appear small, it should be kept in mind that, as discussed in Chapter 1, the number of alcohol outlets in Melbourne has grown sharply in recent years. Between 1996 and 2005, the number of on-premise licences in the postcodes analysed increased by 1,942, while the number of general licences increased by 77 and the number of packaged licences increased by 359. Based on the estimates from this study, such an increase is related to an extra 690 alcohol-related assaults per year.

These results, combined with previous studies that have shown significant effects for outlet density on violence rates over time (122), suggest that greater attention to outlet density is necessary in liquor licensing regimes. While the problems associated with increased outlet numbers are increasingly recognised around inner-city entertainment districts, and attempts by local governments, police and public health professionals to minimise the associated harms are well under way in these areas, (e.g. 331), the results of this study suggest that the current policy focus on late trading inner-city venues is insufficient. A broader approach is needed, with curbs on outlet growth across a variety of areas (and outlet types) required to prevent increases in alcohol-related harms.

Limitations

The focus of this study is the community-level relationship between the number of alcohol outlets and violence. The major shortcoming of the study is the lack of longitudinal control data, including changes over the study period in socio-demographic characteristics of areas and drug market activity. These factors have been shown previously to be correlated with rates of violence (80, 118), and if any of these characteristics changed along with changes in outlet density in the current analyses, then the effects seen could be related to the changes in these unobserved variables. Furthermore, as with the cross-sectional results reported earlier, the study examines the number of outlets of particular types, but does not explore in any detail the nature of the outlets within each category. This is particularly problematic for ‘on-premise’ licences, within which a small licensed restaurant and a large late-night nightclub are equivalent in these analyses. It is well-established that variations in licensed premise characteristics are related to the rates of alcohol-related harm they are associated with (312, 332, 333) and that factors such as trading hours are related to problems within licensed premises (47). Thus, while this study finds significant relationships between outlets and assaults, the nuances of this relationship and information relating particular outlet characteristics to violence are not examined. Further data, on alcohol sales, opening hours, capacity and venue style could provide further insight into how different outlets contribute to the effect of outlet density on assault.

In addition, the study has focussed on changes in outlets and assaults over time in an attempt to provide stronger evidence of a causal relationship than previous cross-sectional work. However, the fact that only nine years of data have been examined is problematic – particularly when major changes to outlet numbers in Victoria took place outside the time-

period analysed. Ideally, time-series models exploring the long-term changes in outlet density and violence could provide more robust evidence of the relationship between outlet density and harm. However, detailed licensing and crime data are not currently available over a longer time period.

5.4 Conclusions

The two studies presented in this chapter have both demonstrated significant positive relationships between the density of alcohol outlets in a neighbourhood and local rates of violence. The studies extend the literature in a number of key ways. Firstly, the cross-sectional analysis highlighted the potential non-linearity of the relationship between the densities of some outlets and violence. The findings suggested that adding general licences to neighbourhoods that already have substantial numbers of pubs will increase violence by more than adding a pub to an area with fewer existing outlets. Secondly, the longitudinal analysis examined the link between outlet density and violence over time and, for the first time, systematically examined the variation in the density-violence links in different types of neighbourhood.

Taken together, the findings from the two studies highlight the role of general licence outlets (pubs/hotels) in generating late-night violence. In both analyses, general licence density had the largest effect on violence rates. Furthermore, the two studies suggest that these outlets are likely to be more problematic in high outlet density areas. The non-linear findings in the cross-sectional study are supported by the longitudinal finding that general outlets had the largest impact on violence rates in the cluster of suburbs that represented the inner-city, high outlet density entertainment precincts. The two analytical approaches also produce consistent findings for on-premise outlets, with the cross-sectional study finding a moderate positive relationship with violence, which the longitudinal study found was most prominent in suburban Melbourne. The findings for packaged liquor outlets were not consistent, with the cross-sectional study finding essentially no significant relationship between packaged liquor and violence, while the longitudinal analysis found a moderate positive relationship overall, concentrated in suburban areas. This inconsistency raises some concerns, with the potential that the effects found in the longitudinal analysis are related to omitted variables (e.g. change in socio-economic status). Contrastingly, the non-linear cross-sectional relationship between packaged liquor and violence was complex, and may have been affected by differences

between suburbs not controlled for in the cross-sectional models. In general, the longitudinal analysis represents a more robust design and is likely to have greater meaning for policy-makers thinking about how to manage packaged liquor outlet density over time.

The two studies presented here suggest that the relationship between alcohol outlet density and violence is complex and dependent on outlet type, existing density of outlets and other neighbourhood contextual factors. In terms of the theoretical frames discussed at the beginning of this chapter, the results presented point towards a combination of amenity and proximity effects of alcohol outlets on violence. The findings for general licences suggest a proximity effect at work, with pubs in entertainment districts increasing rates of violence exponentially. In contrast, the cross-sectional findings for on-premise outlets pointed to a gradual diminishing of their effect in areas of high density, suggesting a saturation of effect. The complex findings for packaged liquor outlets make it hard to point to a clear theoretical explanation from the empirical findings. Most plausibly, based on this work and previous studies (80, 107, 334), packaged liquor outlets work in both ways – higher densities of packaged outlets increase the convenience of alcohol purchasing (and potentially lower the price via increased competition) while potentially also impacting on social disorganisation when they reach particularly high densities.

The policy implications of this work are also important. Liquor licensing policy in Victoria (and elsewhere) needs to consider the likely effects on violence rates of adding new licences to neighbourhoods. The studies presented in this chapter provide strong evidence that additional pubs (general licences) are of particular concern, with both cross-sectional and longitudinal analyses linking them most strongly with assault rates. This evidence contradicts the prevailing view put forward in Victorian licensing reviews and policy documents (12, 16, 21) that there is no relationship between outlet numbers and rates of alcohol-related problems. While the cross-sectional analysis provides some evidence of key threshold levels for outlet numbers, the development of a generic limit across the state is likely to oversimplify the relationship by ignoring key local contextual factors as well as by paying limited attention to differences between premises. Thus, the findings here cannot provide a simple licensing policy solution to issues of alcohol-related violence. Instead, these findings suggest that future licensing policies need to explicitly weigh up the positive effects of a liberalised licensing environment against the negative effects in terms of the likely impacts on violence.

This kind of weighing up is likely to be best informed by local players, and future licensing approaches in Victoria should provide more opportunities for local governments, currently disempowered in licensing processes (335), to contribute to decision making.

The work presented in this chapter has examined the widely discussed problem of alcohol-related violence, adding to a substantial literature linking outlet density and assault. The following chapter focuses on the relationship between alcohol outlet density and family violence, an area that has received substantially less research and policy attention.

Chapter 6. Alcohol outlet density and domestic violence²¹

6.1. Introduction

The previous chapters have demonstrated empirical associations between alcohol outlet density, heavy drinking and violence. This chapter examines the longitudinal relationship between outlet density and domestic violence using a similar analytical approach to the longitudinal analysis of general assault presented in the previous chapter. This introduction will briefly review the literature linking alcohol and partner violence, will summarise the theoretical justification for examining the relationship between alcohol availability and domestic violence and will discuss the previous empirical studies in this area.

Alcohol and domestic violence

Despite consistent findings that heavy alcohol consumption is a strong correlate of partner violence (e.g. 336, 337), there remains controversy in the literature regarding the extent to which alcohol plays a truly causal role in domestic violence incidents (338), with some authors suggesting that the consistent association is spurious and driven by correlations between alcohol consumption, violence and some common third factor (e.g. impulsivity, aggression etc) (339). However, recent studies examining this association have increasingly controlled for a wide range of plausible third factors including age, sex, impulsivity, marital discord, previous partner violence and more (see (340) for a comprehensive review), greatly weakening this potential explanation. In addition, longitudinal studies of heavy drinking men have shown that changes in drinking behaviour over time are correlated with changes in domestic violence perpetration, strengthening the argument that alcohol consumption plays a causal role in partner violence (e.g. 341, 342, 343). Furthermore, controlled experimental studies focussing on verbal aggression between married couples has shown that alcohol consumption increases levels of aggression (344), although these effects may be limited to couples with higher baseline levels of anti-sociality (345). The mechanisms linking alcohol consumption and partner violence are broadly similar to those discussed in the previous chapter for alcohol and violence more broadly. As Klosterman and Fals-Stewart summarise

²¹ This chapter is based on: Livingston, M., *A longitudinal analysis of alcohol outlet density and domestic violence*. *Addiction*, 2011. **106**(5): p. 919-925.

(338), alcohol intoxication can increase the risk of domestic violence via its effects on cognitive processing, thus leading to poorer decision making and misinterpretation of social cues. Furthermore, the disinhibition associated with alcohol intoxication weakens normal restraints against violent behaviour while the increased discounting of future consequences associated with intoxication may cause drinkers to inaccurately assess the potential outcomes of violent acts (346). It is important to note that, despite the substantial evidence that alcohol consumption is a proximal cause of some domestic violence, alcohol consumption is just one of a complex web of causes and that much partner violence occurs without alcohol involvement (336).

Alcohol availability and domestic violence

Theoretical explanations

There is a significant body of literature demonstrating significant environmental risk factors for intimate partner violence, with neighbourhood level socio-economic disadvantage in particular associated with higher rates of domestic violence (even with individual level measures of disadvantage controlled) (347-351). Despite this work, and the substantial literature linking the local alcohol environment with rates of general violence (see previous chapter), the association between alcohol availability and domestic violence has not received a great deal of research attention. Indeed, there have been few attempts to integrate environmental factors into theoretical explanations linking alcohol and domestic violence, with work focussing largely on how the environment can be used to reduce episodes of intoxication (340). In a recent review, Cunradi makes significant steps towards developing theoretical explanations of the potential link between alcohol availability and partner violence, discussing three potential mechanisms operating at the neighbourhood level (352).

Availability theory

As summarised in Section 1.2 of this thesis, availability theory has been the basic justification for most studies of the link between alcohol outlet density and problems. Under this theory, alcohol outlets may influence alcohol consumption amongst people at risk of domestic violence. For example, increases in alcohol outlet numbers in an area may lead to increased overall consumption (through more convenient access, lower prices due to competition or increasingly visible advertising), which in turn will lead to increased heavy drinking occasions and intoxication, thus increasing the risk of domestic violence. An extension of this

relatively simple approach is provided by Freisthler et al., who utilise routine activities theory in the context of child maltreatment (74). They propose that outlets of different types have different impacts on routine drinking activities. Thus, they hypothesise (with some empirical support) that child neglect will be related to on-premise alcohol outlet density (which encourages parents to drink in settings where they cannot supervise their children), and that child physical abuse will be related to off-premise outlet density due to increased drinking and intoxication in the home. In the context of partner violence, off-premise outlets may increase the risk of violence in the home due to increased drinking in that setting.

Contrastingly, increases in outlets with a focus on on-premise alcohol consumption may alter drinking practices such that more alcohol is consumed at these venues, which are typically the location of heavier drinking occasions (353), again increasing intoxication and risk of domestic violence taking place.

Social disorganisation theory

Secondly, in line with social disorganisation theory discussed in the previous chapter, Cunradi proposes that alcohol outlets in a neighbourhood may act as signs that the normative mechanisms of informal social control are not functioning well, thus creating an environment where potential offenders feel as though violence is more acceptable. This explanation is most plausible in social contexts where alcohol outlets contribute to negative perceptions of a neighbourhood, via their associations with increased litter, noise, vandalism and property damage (121, 354).

Assortative drinking theory

Finally, Cunradi makes use of Gruenewald's theory of assortative drinking (73), suggesting that areas with higher densities of alcohol outlets may provide drinking environments where like-minded drinkers cluster together, mutually reinforcing norms and attitudes conducive to domestic violence. If, as Gruenewald proposes, high outlet density neighbourhoods tend to have more outlets that reinforce aggressive forms of masculinity, then there is the potential that the norms and behaviours of drinkers in these neighbourhoods will be affected to the point that rates of domestic violence are influenced. While Cunradi provides some situations in which this mechanism could operate via off-premise outlets, it seems much more plausible in an urban Australian setting that it would mostly be driven by on-premise drinking outlets.

Empirical studies

As discussed earlier, there has been only a small amount of research examining whether alcohol availability is related to partner violence. Given the substantial literature examining the impact of alcohol prices on consumption and alcohol-related problems, there has been surprisingly little attention paid to price effects on partner violence. The three studies identified provide little evidence that changes to alcohol prices affect domestic violence. A recent study from Finland examined the effect of a sharp reduction in spirits prices, finding if anything a slight reduction in domestic violence (355). Two cross-sectional studies using cross-state variations in U.S. alcohol prices found substantial relationships between price and partner violence (356), but only weak correlations between price and rates of child abuse (356). There is more empirical support for a relationship between the physical availability of alcohol and domestic violence. Despite largely focussing on the impacts on consumption, initial studies from the Nordic countries found substantial effects on domestic incidents from changes to alcohol supply, including changes to the days on which alcohol was permitted to be sold, the introduction of beer into grocery stores and production strikes resulting in alcohol shortages (85). Similarly, studies examining the impacts of restrictive policies in remote, largely Indigenous, communities in Australia have found that reductions in days or hours of trade and the removal of particularly high-risk alcohol products have reduced domestic violence rates in these communities (357-360).

There is a small body of research specifically examining the association between the density of alcohol outlets in an area and the area's rate of domestic violence. This link is a straightforward extension of the previously discussed role of alcohol in domestic violence and the repeated studies demonstrating clear relationships between community-level factors (predominantly measures of disadvantage or social disorganisation) and domestic violence. An early study in New Jersey (154) found a positive relationship between total alcohol outlet density and police-recorded rates of domestic violence, but this relationship was no longer evident once socio-demographic control variables (e.g. social disadvantage, population movement etc.) were controlled for. These findings suggest that the geographical relationship between alcohol outlet density and domestic violence may be due to a common relationship with other socio-demographic factors. In contrast, a recent study by McKinney et al. (153) combined data from a national (U.S.) population survey and administrative data sources to assess whether self-reported experiences of intimate partner violence were related

to alcohol availability, finding a positive link between alcohol outlet density and male-to-female partner violence. McKinney et al. also examined whether particular outlet types were problematic, finding that on-premise outlet density was significantly related to partner violence, but not off-premise. This study adjusted for a wider range of socio-economic and demographic characteristics, across individual, couple and community levels, finding that the relationship between outlet density and partner violence persisted with these factors controlled for. They also found that alcohol outlet density effects were stronger for couples who reported alcohol-related problems. Cunradi et al. used four years of data from Sacramento, California to conduct a Bayesian space-time analysis of the neighbourhood level associations between outlet density and intimate partner violence rates (based on police data) (152). As this study was based on an ecological design (rather than the multi-level approach used by McKinney et al.), only community-level correlates could be controlled. Thus, a range of population and socio-economic measures at the community level were incorporated into the final models, which found significant associations between off-premise outlet densities and rates of partner violence. Finally, a cross-sectional Australian study examined police data, using assaults on private premises as a proxy measure for domestic violence, and found that total volume of beer sold in a region was related to rates of violence, but that geographic measures of outlet density (i.e. outlets per square kilometre) were not (361).

The small literature exploring the relationship between alcohol outlet density and assault is thus characterised by a wide variety of methodological approaches and a diverse set of findings. Two studies found no direct effect for outlet density on domestic violence, while the other two (including one with a strong longitudinal design) found significant positive effects, but for different licence types. Therefore, there remains substantial uncertainty in terms of the empirical relationship between outlet density and violence. This chapter addresses this uncertainty, presenting a longitudinal analysis of the relationship between alcohol outlet densities and rates of domestic violence. The study uses data at the postcode level from Melbourne, Australia from 1996 to 2005 and uses spatial panel data methods. This time period and setting provide a particularly interesting frame for the study, with significant increases in alcohol availability taking place in Melbourne across the late 1990s and early 2000s (see Chapter 1). In addition, the analyses undertaken in this chapter examine whether the relationships between alcohol outlet density and domestic violence vary across different types of neighbourhood.

6.2. Methods

This study is a population level analysis of domestic violence, focussing particularly on the longitudinal relationship between alcohol availability and domestic violence rates at a neighbourhood level.

Geographical units and clusters

Postcode level aggregate data on alcohol outlets and domestic violence were used to assess whether annual changes in alcohol outlet density were related to annual changes in rates of domestic violence. The study uses data from the same 186 postcodes used in the study presented in the previous chapter. In 2005, the average postcode was 14.7 kilometres square, with a resident population of 15,600 people. These are approximately half the size of U.S. zip codes, but much larger than postal areas in the United Kingdom. Following the overarching set of models, this chapter includes analyses of the association between outlet density and domestic violence in five sub-groups of postcodes. These sub-groups are based on the clusters developed in the previous chapter and presented in Table 12. The derivation of these clusters won't be revisited here. Broadly, the five clusters represent: 1) the inner-city entertainment precincts, 2) inner-urban suburbs, 3) socio-economically advantaged suburbs, 4) fringe (or peri-urban) suburbs, and 5) socio-economically disadvantaged suburbs.

Licensing data

This analysis uses the same liquor licensing data described previously, and focuses on the same three categories of liquor outlets: general licences (793 in the study area in 2005), On-premise licences (3,502 in the study area in 2005) and packaged licences (974 in the study area in 2005). Because this study was concerned with an outcome occurring in domestic settings, alcohol outlet density was calculated for each of these categories as the number of outlets per 1,000 residents.

Domestic violence data

Domestic violence incident data were provided by the Victorian Police Service from their Law Enforcement Assistance Program (LEAP) database. The data used are counts of 'family incidents' (here equated with incidents of domestic violence) recorded by the police for each postcode in the study area for the period 1996 to 2005. The rate of family incidents recorded by the police increased by 18.3% across the study period. These incidents fall somewhere between calls and arrests – they are incidents where the police deem that an offence has taken

place and will thus not include all calls, but will include offences that do not result in an arrest. It should be noted that using a policing driven measure of domestic violence creates the potential for biases in the analyses (e.g. reporting rates may be higher in some areas and thus higher rates recorded in those areas). In addition, many incidents of domestic violence are likely to be excluded from police-based statistics with, for example, the Australian 2005 Personal Safety Survey (297) finding that just 36 per cent of female victims of physical assault reported the incident to the police. This represents a significant source of potential bias to the study, particularly if reporting rates vary along with the availability of alcohol. There is little published research on which factors influence the reporting of domestic violence in Australia, although there is research from the U.S. indicating, for example, that non-white victims are more likely to report domestic violence (362), so the risk of bias from this measure is not negligible. However, police data is often used in these kinds of analyses (e.g. 117, 152, 348), and the use of a control variables related to police reporting rates (e.g. socio-economic disadvantage) will ameliorate this bias somewhat. While the previous chapter used count-based offence data as its outcome variable and some previous studies of violence have used counts or rates based on geographic measures (e.g. 80), the fact that these offences generally took place in residential settings meant that it made the most sense to use rate per 1,000 residents per year.

It is worth noting that the family incident data used in this section contain some overlap with the assault data presented in the previous chapter. Comprehensive longitudinal data on this overlap are not readily available, but the most recent Victorian Police crime statistics publication (363) provides sufficient data to estimate the extent of the overlap. In 2009/10, around one-quarter (25.1%) of offences recorded as assaults in the LEAP database were also recorded as family incidents. Thus the analyses presented in the previous chapter largely examine non-domestic violence, with 74.9% of assault offences not related to domestic violence. Similarly, the majority of the family incidents examined in this chapter (74.5%) were not included in the assault data, either because they incorporated other offences (e.g. property damage, harassment, breaches of protective orders) or because police dealt with the situation without making a charge. The relationship between the two outcomes is presented graphically below (Figure 14).

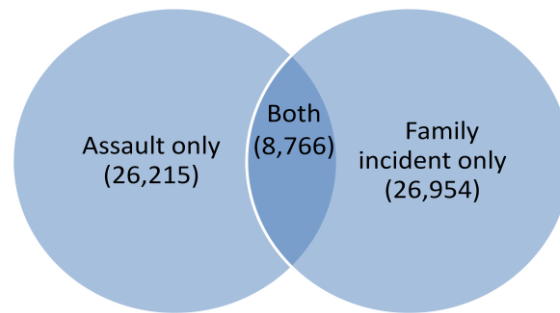


Figure 14 - Relationship between Victorian Police records of family incidents and assaults, 2009/10

Population data

Population data for each postcode came from Census data for 1996 and 2001 and Estimated Residential Population data for 2005 (218, 324). As with the previous chapter, population estimates for the remaining years (1997-2000, 2002-2004) were derived using simple linear interpolation, which provide a reasonable approximation of population change over the study period.

Socio-economic data

Given the importance of socio-economic status as a neighbourhood level predictor of domestic violence rates (e.g. 351), it was necessary to incorporate a control variable capturing neighbourhood change in socio-economic status over time. Data on the socio-economic disadvantage of each postcode were derived from the Australian Bureau of Statistics Socio-Economic Index for Areas (SEIFA) index of relative disadvantage (IRSED) (364). This index is based on a range of variables collected during the five-yearly national Census and provides a composite measure of socio-economic disadvantage in a neighbourhood. IRSED scores range from a low of around 700 (most disadvantaged) up to a high of around 1200 (least disadvantaged). SEIFA data were available for 1996, 2001 and 2006 and data were linearly interpolated for the intervening years.

Analysis

The dependent variable for the regression analyses undertaken in this study was the annual rate of police-recorded domestic violence incidents across each of the 186 postcodes in the study area. The independent variables were the alcohol outlet density rates (both the overall rate and the rates of individual licence categories) along with the population of the residential postcode and the SEIFA index of relative disadvantage. The main aim of the study was to

assess how changes in postcode-level outlet density related to changes in domestic violence rates over a ten year period (1996-2005). To do this, this study uses the same cross-sectional time-series approach as the previous chapter. Fixed-effects models, which are asymptotically consistent and appropriate for situations such as this where the units are not part of a random sample from a larger population are used again. In particular the emphasis of fixed effects models on maximising the explained variance within units means that the results of this study are truly longitudinal. To ensure that broader trends did not influence the results, the model included time-period fixed-effects as well as postcode-level fixed effects. This is a very conservative modelling strategy, ignoring cross-sectional differences between postcodes and overall trends, and instead only making use of variation within postcodes. The first model developed examines the relationship between total licence density and domestic violence. This is followed by three models examining each type of licence in turn. Next, all three licence categories were included in a single model to try to determine which were the most important in explaining rates of domestic violence. Finally, models incorporating all licence types are developed separately for each of five types of postcode (based on socio-demographic data, see previous chapter) to assess whether the effects of alcohol outlets on domestic violence are context dependent.

As with the previous chapter, this study uses a spatial fixed-effects modelling procedure based on maximum likelihood estimators to ensure that spatial correlations between the study units did not bias the results. Conditional Auto-Regressive (CAR) spatial-error panel models with fixed-effects for time and postcode were developed, using simple Queen's contiguity weights, whereby the influence of all directly neighbouring postcodes is considered, but not any influence of non-neighbouring postcodes. These models were developed using the Matlab spatial econometrics toolbox developed by Elhorst (204).

6.3. Results

Descriptive statistics for each of the measures used in the study are presented in Table 14. There is clearly sufficient variation over time within the postcode units to be able to assess the temporal relationship between outlet density and domestic violence. Even for on-premise outlet density, which has doubled in the study area over the time-frame studied, enough postcodes (10%) have experienced reductions in on-premise density to provide sufficient variance for the fixed-effects modeling.

Table 14 - Descriptive statistics of domestic violence study measures

Variable	Mean	S.D.	Min	Max	Total net change	Proportion postcodes decreasing
Domestic violence rate (per 1,000)	4.76	0.06	0	19.81	+18.30%	33.9%
General licence rate (per 1,000)	0.39	1.29	0	18.52	-1.00%	63.4%
On-premise licence rate (per 1,000)	0.28	0.21	0	2.06	+100.70%	10.2%
Packaged licence rate (per 1,000)	1.15	3.35	0	49.35	+41.60%	20.3%
IRSED (lower score = more disadvantage)	1032.55	78.30	706.96	1162.48	-0.4%	50.7%
Population (x 1,000)	15.61	10.02	0.39	55.92	+11.90%	18.9%

The results of the fixed-effects regression models for each licence type individually are presented in Table 15. For the sake of clarity, the year dummy variables (which control for overall time trends) are not presented. These dummies were generally significant and positive in all models, indicating the city-wide increasing trend in reported domestic violence rates over the time-period.

The overall model found a small but significant positive effect for total licence density, with an increase in the overall rate of alcohol outlet density of 1 outlet per 1,000 residents resulting in an increase in the domestic violence rate of 0.08 per 1,000 residents. When the separate outlet categories were analysed, there were significant positive effects for each of the categories examined. The positive effects for general and on-premise licences were relatively small – an increase of one general outlet per 1,000 residents in a postcode was associated with an increase of 0.28 domestic violence incidents per 1,000, while an increase of one on-premise outlet per 1,000 residents was associated with an increase in the domestic violence rate of 0.11. The most substantial effect was found for packaged liquor outlets, with an increase of one packaged outlet per 1,000 related to an increase of 1.36 in the domestic violence rate. To provide some context, these effect sizes represent increases of 5.9%, 2.3% and 28.6% respectively from the overall mean of the domestic violence rate (4.76/1,000 residents).

Table 15 - Fixed-effects models of alcohol outlet density and domestic violence – total licence density and separate models for each licence category

Variable	Model 1 – Total licences			Model 2 – General licences			Model 3 – Packaged licences			Model 4 – On-premise licences		
	<i>B</i>	<i>t-value</i>	<i>p</i>	<i>B</i>	<i>t-value</i>	<i>p</i>	<i>B</i>	<i>t-value</i>	<i>p</i>	<i>B</i>	<i>t-value</i>	<i>p</i>
Residential population (1000s)	-0.01	-1.18	0.24	-0.01	-1.23	0.22	-0.01	-0.94	0.35	-0.01	-1.26	0.21
IRSED (lower = disadvantage)	-0.02	-28.25	<0.01	-0.02	-27.99	<0.01	-0.02	-27.51	<0.01	-0.02	-28.32	<0.01
Licence density	0.08	7.32	<0.01	0.28	6.93	<0.01	1.36	5.45	<0.01	0.11	7.21	<0.01
Spatial error term	0.60	26.11	<0.01	0.59	25.33	<0.01	0.59	25.50	<0.01	0.60	26.37	<0.01

When all three outlet categories were entered into the same model (Table 16), only packaged outlets remained significant, with an increase of 0.66 incidents of domestic violence per 1,000 residents for each additional packaged outlet. It is worth noting that the changes in availability across the three types of outlet are correlated over time. The correlation between the changes in packaged liquor outlet density and general outlet density are the highest (0.67, $p < 0.01$), while the remaining correlations were non-significant.

Table 16 - Fixed-effects models of alcohol outlet density and domestic violence – all three licence categories in a multivariate model

Variable	B	t-value	P
Residential population (1000s)	-0.01	-0.86	0.39
IRSED	-0.02	-27.67	<0.01
General licence density	0.05	0.46	0.64
Packaged licence density	0.66	2.35	0.02
On-premise licence density	0.07	1.66	0.10
Spatial error term	0.60	25.67	<0.01

The results for the five postcode clusters are presented in Table 17. These models highlight the role of packaged liquor outlets, with significant positive relationships between packaged outlet density and domestic violence in four of the five postcode clusters (all except the fringe postcodes). In addition, general outlet density was positively related to domestic violence in the inner-city, inner-urban and fringe postcodes, but not in the two suburban clusters. On-premise outlets were not significantly related to domestic violence in any of the five clusters.

Across almost all the models presented in this chapter, the effect of the SEIFA index of relative disadvantage was significant and negative, highlighting the relationship between increased levels of disadvantage and increased rates of recorded domestic violence. The results also indicated significant positive spatial autocorrelation in the data across almost all the models. The spatial error terms reported are generally substantial (~0.6), suggesting that rates of domestic violence are highly correlated between neighbouring postcodes and highlighting the risks of modeling these data with non-spatial methods.

Table 17 - Fixed-effects models of alcohol outlet density and domestic violence across five postcode clusters – all three licence categories in multivariate models

Variable	1 – Central suburbs			2 – Inner-urban suburbs			3 – Advantaged suburban			4 – Fringe			5 – Disadvantaged suburban		
	β	t	p	β	t	p	β	t	p	β	t	p	β	t	p
Residential population (1000s)	-0.67	-3.04	0.00	0.17	5.04	0.00	-0.02	-3.21	0.00	0.12	2.80	0.01	-0.01	-0.87	0.38
IRSED (lower = disadvantaged)	-0.01	-0.45	0.65	-0.01	-1.93	0.05	-0.03	-15.62	0.00	-0.02	-3.60	0.00	-0.02	-6.95	0.00
General licences	1.10	2.72	0.01	0.82	3.39	0.00	0.24	0.48	0.63	1.19	3.69	0.00	-1.41	-0.80	0.42
Packaged licences	4.38	3.75	0.00	2.03	3.24	0.00	1.65	3.67	0.00	-0.21	-0.36	0.72	2.84	2.15	0.03
On-premise licences	-0.18	-1.56	0.12	0.12	1.05	0.30	0.08	0.64	0.52	0.11	0.84	0.40	-0.30	-0.44	0.66
Spatial error term	0.08	0.47	0.64	0.43	7.07	0.00	0.50	15.05	0.00	0.15	2.18	0.03	0.61	16.76	0.00
No. of postcodes (N)	7			23			80			34			42		

6.4. Discussion

This study adds to the small body of literature examining the connections between alcohol availability and domestic violence, providing rare longitudinal evidence of a relationship between alcohol outlet density and domestic violence.

The relationships found by this study suggest that general (or pub) licence and packaged (off-premise) licence densities are significantly related to rates of domestic violence at the community level, with the largest and most consistent effects found for packaged liquor outlets. These findings fit with theoretical justifications of the link between alcohol outlet-density and domestic violence. Firstly, the strongest link is found for the type of outlet that sells alcohol for off-premise consumption. If the density of alcohol outlets is related to consumption levels (as suggested by some previous studies (164)), then it is plausible that increasing density of these particular outlets will result in increasing consumption of off-premise alcohol. In addition, the work presented in Chapter 4 of this thesis provided some evidence of an association between packaged alcohol outlet density and increased rates of drinking to intoxication. Thus, there is a plausible argument that increases in packaged liquor outlet density in a neighbourhood will lead to increased rates of heavy alcohol consumption. This consumption is likely to take place within the home, potentially increasing the risk of domestic violence. The positive association between general outlet density and domestic violence may reflect the effect of these outlets (where heavy alcohol consumption is common (353, 365)) on routine drinking activities, with increases in their density encouraging heavier episodes of drinking. These licences have been linked in the previous chapter to general levels of assault and are often venues in which alcohol consumption is the main activity.

These rationales rely on a link between outlet density and consumption, which remains somewhat contested (e.g. 169). This contrasts with studies focusing on outlet density and public violence, where a variety of theoretical justifications have been put forward to explain the link without requiring changes in consumption. In this context, Cunradi's theory that alcohol outlets may affect domestic violence rates via their role as markers of social disorganisation and low informal social controls is worth considering (352). It is not possible to disaggregate this potential explanation from the consumption-focused reasons put forward

earlier based on the results of this study, and further work is required to develop a more robust understanding of the ways in which alcohol outlets are related to violence in the home.

The findings of the analyses of sub-clusters of Melbourne postcodes provide a broadly consistent picture, with general outlets having a small impact and packaged liquor outlets a substantially larger impact on domestic violence rates in most neighbourhood types. The findings also point to some variations in the effects of outlets on domestic violence. The lack of effects for general outlets in suburban areas of Melbourne may be caused by the tendency for residents of these neighbourhoods to consume more of their alcohol at homes or to travel outside their neighbourhood to visit pubs. There is no data available on how people in different areas make use of licensed venues, so this is speculative, but the lower densities of general outlets in these areas suggests that they are not widely used by suburban residents (for example, club licences may be more commonly used in the outer suburbs). This contrasts with the significant effect found for general licences in the fringe suburbs of Melbourne, which also have relatively low densities of general outlets. It is possible that the significant travel times from these suburbs to the inner-city entertainment precincts means that more residents choose to drink within their own neighbourhoods, but again this is speculative.

The results of this study are consistent with a growing number of studies linking alcohol outlet density and domestic violence (152, 153), adding to the evidence that alcohol availability is risk factor for domestic violence. In particular, the study finds longitudinal relationships between outlet densities and domestic violence rates, while utilising a very conservative study design, with cross-sectional variation, overall trends and spatial autocorrelation controlled. It thus provides the strongest evidence yet for a direct effect of outlet density on domestic violence. The study's findings particularly implicate packaged liquor licences, supporting the results of the only other longitudinal analysis of this issue (152).

The results of this study suggests the need for a more cautious approach to liquor licensing policy in Victoria than was demonstrated across the study period, a decade that saw the doubling of the number of packaged liquor outlets in the state. In addition, it draws attention to the risks associated with the proliferation of packaged liquor outlets, a section of the market that has received less policy attention in Victoria than the late-night entertainment precinct venues (3).

Limitations

It is possible that the relationships found in this study reflect changes in socio-demographic factors which are correlated with both alcohol outlet density and domestic violence, although the incorporation of a broad measure of socio-economic disadvantage reduces the likelihood of this happening. The use of this simple composite measure of disadvantage represents a major limitation of the study. However, due to the limitations of data available between Censuses in Australia more detailed contextual variables were impossible to incorporate. The relative robustness of this measure for assessing overall disadvantage and the conservative modeling design adopted in this study should mean that this limitation is not likely to have greatly influenced the alcohol effects observed. The use of a police-derived measure of domestic violence is another reason to be cautious when interpreting the results presented here. The low rate of reporting of domestic violence to police and the potential population disparities in reporting rates (366) provide the potential for substantial biases in the outcome measure used here, although disparities in reporting would need to be correlated with the alcohol availability measures to greatly influence the findings of this study.

Finally, as with the rest of this thesis, the outlet measures used in this chapter are simple counts of outlets across localities and ignore a range of outlet-specific factors likely to be important (e.g. size, trading hours, turnover). Thus, the findings presented here are necessarily broad and simplified. For example, small boutique packaged liquor outlets are likely to have substantially different associations with domestic violence rates than warehouse-style bottle-shops. Indeed, cross-sectional analyses undertaken using data from Western Australia suggest that the amount of alcohol sold by premises is a key driver of local rates of domestic violence (361). The limitations of the analyses presented here are a consequence of limitations in the liquor licensing data available in Victoria, a theme that will be returned to in the final chapter of this thesis.

6.5. Conclusions

The study presented in this chapter, demonstrating longitudinal associations between alcohol outlet density and domestic violence adds to the evidence of the earlier chapters on high-risk drinking and general assault rates. Taken together, these findings suggest that the changes in alcohol availability seen in Victoria in recent decades have contributed

substantially to the simultaneous increase in acute-alcohol related harms observed in the state. The following chapter will broaden the focus and explore whether alcohol outlet density is associated with chronic alcohol-related harm.

Chapter 7. Alcohol outlet density and alcohol-related hospital admissions: comparing the impacts on acute and chronic harms²²

7.1. Introduction

The studies examining the relationships between alcohol outlet densities and alcohol problems at a community level that have been presented thus far in this thesis have all focussed on acute alcohol-related harms (heavy episodic drinking, general assault and domestic violence). The work presented in this chapter shifts the emphasis to the longitudinal associations between alcohol outlet density and hospitalisations due to chronic, alcohol-caused conditions. In addition, the study presented in this chapter analyses the effects of alcohol outlet density on assault-related hospitalisations using the same approach, allowing for the direct comparison of the effects of different outlet types on acute and chronic harms. The remainder of this introduction will provide a brief review of the literature linking alcohol availability and chronic outcomes and a discussion of the routine drinking activities theory to be tested here. It should be noted that this chapter focuses on alcohol-specific chronic outcomes, conditions where the causal role of alcohol is unambiguously identified. These conditions are only a subset of the chronic illness *attributable* to alcohol, which include heart disease, a range of cancers and many other conditions (221).

While this study incorporates an analysis of the relationship between alcohol outlet density and violence, the empirical literature on this question will not be reviewed here. Interested readers are referred to Chapter 5 for a thorough discussion of this area of research.

Alcohol availability and chronic disease

Historically, much of the focus of alcohol research was on issues related to alcoholism. Thus, there has been a substantial amount of research into how various changes to alcohol policy impact on chronic alcohol-related harms such as dependence or liver cirrhosis mortality. This is particularly true of studies of price. Most famously, the dramatic increases in Danish alcohol taxes during World War One resulted in sharp declines in deaths from liver cirrhosis

²² This chapter is based on: Livingston, M., Alcohol outlet density and harm: comparing the impacts on violence and chronic harms. *Drug and Alcohol Review*, 2011; 30(5):919-925.

and alcohol dependence (367). Similarly, Cook and colleagues have highlighted the association in the U.S. between state level alcohol excise and cirrhosis mortality, suggesting chronic drinkers are affected by even small differences in price (368-370).

Studies focussing on large changes in physical availability have also generally shown that rates of alcohol-caused chronic disease respond to availability. For example, severe alcohol shortages in Paris during World War Two resulted in a halving of the cirrhosis mortality rate between 1942 and 1943 (371). The Nordic studies summarised by Room and colleagues (85) generally show that large changes to outlet numbers (usually via the introduction or removal of beer from supermarkets) were followed by corresponding changes in rates of cirrhosis and dependence. For example, it was estimated that the opening up of the Finnish alcohol market in 1969 resulted in a doubling of hospitalisation rates for alcoholic psychosis and alcoholism and a 20% increase in cirrhosis morbidity. Across all alcohol-specific causes, mortality rates jumped nearly 60% in a single year. Similarly, Ramstedt (87) estimated that the removal of medium-strength beer from Swedish grocery stores reduced alcoholic psychosis, dependence and alcohol intoxication hospital admissions by 20%. These studies demonstrate that, while at the individual level most of these conditions take a long period of heavy drinking to develop, their rate at the population level can change immediately following changes to population level alcohol consumption. For example, studies assessing the correlation between per capita alcohol consumption and liver cirrhosis mortality over time have demonstrated that around half of the effect of changes in consumption takes place within a year (372, 373). Thus, there is little risk that the impact of changes in alcohol availability on these kinds of outcomes will be hidden by the time lags between the availability changes and changes in outcome rates.

In the late 1970s and early 1980s, there were a series of U.S. studies examining how state-level differences in alcohol availability (usually measured via outlets per capita) were related to state level differences in rates of alcoholism or cirrhosis mortality. These studies produced fairly mixed results. For example, depending on the kinds of state-level control variables that were incorporated, some studies found no real association between availability and alcoholism or cirrhosis rates (40, 64, 82), while others found that significant effects, but for different types of outlets (84, 374). These studies have been heavily criticised for not dealing sufficiently with state level cultural differences (19), and the lack of clear and consistent findings despite their broadly similar approaches and data sources suggests that the state-

level cross-sectional designs used were of limited utility. In an attempt to overcome these limitations, some authors used smaller geographical units in cross-sectional studies. For example, Watts and Rabow conducted a study of data from 213 Californian cities which found significant city-level associations between alcohol availability and cirrhosis mortality (375). Using a broader set of outcomes, Beshai found significant correlations between alcohol outlet numbers and mortality from cancer, heart disease and alcohol-specific causes within Los Angeles County (376), however this work remains limited by the fairly crude control variables available, the cross-sectional design and lack of controls for the spatial nature of the data. Similarly, Tatlow et al. found a correlation between zip code rates of alcohol-related disease morbidity and alcohol outlet density (130). However, this was a fairly straightforward cross-sectional analysis that did not control for many socio-demographic variables or deal with spatial autocorrelation. In addition, its use of a combined measure of outlet density (rather than separating on- and off-premise outlets), limits its usefulness for informing policy.

More recently, Theall et al. (129) conducted a multi-level study at the census tract level in Los Angeles, combining a large population survey that collected data on self-reported health conditions and licensing data. Their study found a significant correlation between self-reported liver disease and local off-premise outlet density. Importantly, this relationship was entirely mediated by self-reported consumption levels, suggesting that any effects of off-premise alcohol outlets on long-term health conditions occur primarily through the relationship between off-premise outlets and level of consumption. In a rigorous small-area longitudinal analyses, Stockwell et al. examined the relationship between changes in number of alcohol outlets and change in alcohol-related mortality, using the privatisation of the off-premise alcohol retail market in British Columbia (91). They found a significant increase in alcohol-related mortality in neighbourhoods where retail outlet numbers increased, but their outcome measure combined acute and chronic causes of mortality, making it hard to ascertain whether this association was significant for chronic conditions.

Thus, the research that has been undertaken has generally found significant associations between the physical availability of alcohol and chronic outcomes, although these findings are strongest for abrupt major changes in availability, with the literature focussing on more subtle differences in outlet density fairly limited.

Integrating theoretical explanations across acute and chronic harms

Clearly, for alcohol outlet density to causally relate to alcohol-caused chronic disease, then density levels need to impact on alcohol consumption in some way. Theall's multi-level study discussed above found that the association between off-premise outlet density and self-reported liver disease was almost entirely mediated by consumption levels, suggesting that off-premise outlets influence consumption which affects the likelihood of chronic outcomes. However, as discussed in section 1.2 above, the evidence that consumption levels are influenced by outlet density is mixed and inconclusive. Certainly the data presented in Chapter 3 of this thesis suggest little change in consumption in Victoria during a period over which outlet numbers have increased dramatically. The findings from the Nordic studies discussed above generally show effects on chronic outcomes of greater magnitude than the effects on consumption levels, suggesting that sharp changes to availability have a disproportionate impact on vulnerable heavy drinkers. This provides a potential explanation for the mixed results discussed above – gradual changes to outlet density have very limited or no impact on the overall consumption of most of the population, instead affecting primarily vulnerable sub-groups (marginalised heavy drinkers, young people, etc).

The theoretical justifications for a causal relationship between alcohol outlet density and acute harms (particularly violence) have been discussed at length in previous chapters. To briefly summarise, there are two broad theoretical approaches: the first suggests that alcohol outlets contribute to violence by altering consumption levels or patterns amongst the drinking population while the second focuses on the role of alcohol outlets as markers of social disorganisation or as attractors that produce clusters of potential offenders and victims in environments with limited social controls (73). Stockwell and Gruenewald (67) attempted to integrate these approaches, discussing how changes to availability can influence 'routine drinking activities' without necessarily changing overall consumption, by altering the context or behaviours surrounding drinking. Thus, for example, increasing numbers of on-premise alcohol outlets in close proximity to each other might increase violence by exposing drinkers to more violence-prone situations (e.g. crowds of other drinkers). This explanation borrows heavily from criminology and routine activities theory (68), which posits that crime is more likely in situations where motivated offenders, vulnerable potential victims and a lack of capable guardians occur. Changes to drinking contexts such as those discussed can thus be

thought of as changes which increase the likelihood of people's routine activities resulting in situations where alcohol-related problems are more likely to occur.

While this approach provides some insight into the ways that alcohol outlet density may affect acute problems such as violence, it seems particularly relevant to on-premise drinking and provide limited insight into why the density of off-premise alcohol outlets should be related to alcohol-related problems (122, 377). Freisthler et al.'s again provides a useful means of thinking about the theoretical underpinnings of associations between alcohol outlets and a range of harms (74). Their work provided one attempt to explain the effects of off-premise alcohol outlets on problems, by examining two distinct forms of child maltreatment: neglect and physical abuse. Their study found an effect of on-premise alcohol outlets on neglect, while off-premise density was associated with physical abuse. This was explained in terms of routine activities, with parents in neighbourhoods with more on-premise outlets spending more time drinking away from their children, while parents in neighbourhoods with more off-premise outlets drank more frequently at home, increasing the risks of intoxication and violence within the home.

This approach, assessing whether different types of outlets are related to different types of outcome, provides a means for delving more deeply into the mechanisms underlying the relationships found in the disparate empirical studies undertaken in different localities, using different data sources and different analytical methods (48). There have been surprisingly few attempts to conduct these kinds of analyses, with most authors focussing on a single outcome. There is good reason to expect that different types of outlet would contribute differently to different types of harms. As Freisthler et al. (74) demonstrated, different outlet types are likely to influence drinking situations in different ways, which will have differing implications for alcohol-related problems. In addition, there are substantial price variations between on- and off-premise alcohol (related in part to the costs of the service environment for on-premise drinking), which may also influence how the densities of different outlet types influence harm. While there are no Victorian estimates available of this price difference, national data suggests that alcohol bought in on-premise settings generally costs between two and five times as much as that bought from off-premise outlets, with this gap particularly wide for wine (290).

Thus, in an attempt to develop a broader empirical basis for developing theories relating alcohol outlet density and alcohol-related problems, the current chapter attempts to ascertain how two distinct sets of alcohol related harms (violence and chronic alcohol-related health problems) are related to three categories of alcohol outlets (packaged liquor outlets, pubs/hotels and bars and restaurants).

The hypotheses of the current study are:

1. That the density of outlets focussed on on-premise drinking (pubs) is more related to rates of violence and less to alcohol-specific disease.

This hypothesis is dependent on the criminological theories discussed earlier. Higher density of places where alcohol is consumed is likely to lead to higher densities of potential victims and motivated offenders and thus to higher rates of violence

2. Contrastingly, that the density of off-premise alcohol outlets is more related to rates of chronic alcohol-caused disease than to violence (although there may be some association between off-premise outlets and violence-related admissions due to the link between packaged liquor and domestic violence found in the previous chapter).

Changes to the density of off-premise outlets are most likely to reduce the real costs of alcohol for vulnerable drinkers, who can't easily plan their purchases and consumption ahead of time. Thus, the reduced convenience costs relating to higher densities of off-premise alcohol outlets may also have greater impact on drinkers who consume alcohol in problematic ways (e.g. dependent drinkers). It is likely that marginalised dependent drinkers source much of their alcohol from cheaper off-premise outlets and lack the resources to travel widely to buy alcohol or to purchase alcohol in bulk to avoid the need for regular purchasing. Thus it is likely that changes in the density of these outlets will affect rates of the chronic harms associated with very heavy drinkers.

7.2. Method

As with the analyses presented in previous chapters, this study uses an ecological design, based on postcode level data from Melbourne. Data on liquor licences, hospitalisations and

socio-economic disadvantage were aggregated for 186 postcodes in the greater Melbourne area that have had no boundary changes across the period of the study (1994 – 2007). In 2007, 3.15 million people lived in these 186 postcodes, representing around 85% of the total population of greater Melbourne. All measures except for the index of socio-economic disadvantage are rates per 1,000 residents.

Data

Liquor licensing data

Responsible Alcohol Victoria in the Victorian Department of Justice provided annual data on active liquor licences from 1994 through to 2007. As discussed earlier, the accuracy of the postcode information provided with these data was estimated at 98%. The same three categories of liquor licences were used in this analysis as in the previous work: general, packaged and on-premise. General licences, of which there were 901 in 2007 in the study area, allow the licensee to sell alcohol for consumption both on and off the premises, and apply to taverns, hotels, pubs and some nightclubs. On-premise licences, of which there were 3,664 in 2007, allow the licensee to sell alcohol on the premises only, and generally apply to restaurants and bars. Packaged licences, of which there were 1,024 in 2007, are used for off-premise alcohol sales and apply to retail liquor stores (including some supermarkets).

Hospitalisation data

Rates of violence and chronic disease were derived from hospitalisations data sourced from the Victorian Admitted Episode Dataset (VAED). The primary diagnosis for each admission was used to classify hospitalisations as assault or as alcohol-related chronic disease. Between 1994 and 1997, hospital admissions in Victoria were coded according to the International Classification of Diseases 9th edition (ICD-9), while from 1998 to 2007, ICD-10 was used. Reviews of the VAED under both ICD-9 and ICD-10 coding schemes show that the data coding is reliable and that the transition to ICD-10 was accurate (378, 379) and that there were no changes to ICD codes between ICD-9 and ICD-10 for these diagnoses.

Assault admissions were coded using the external cause codes in the ICD system. Thus, between 1994 and 1997, admissions for injuries with external codes between e960 and e969 were counted as assaults. From 1998 onwards external codes for assault were between X85 and Y09. Alcohol-related chronic disease admissions were based on admissions for wholly

alcohol-caused diagnoses for conditions related to long-term consumption of alcohol. See Table 18 for the full list of diagnoses included in this category²³.

Table 18 - Diagnoses and ICD-codes classed as alcohol-specific chronic disease

Diagnosis group	ICD-9 Codes	ICD-10 Codes
Mental and behavioural disorders due to alcohol (excluding acute intoxication)	291.X, 303.X	F10.1 – F10.9
Alcoholic polyneuropathy	357.5	G62.1
Alcoholic cardiomyopathy	425.5	I42.6
Alcoholic gastritis	535.3	K29.2
Alcoholic liver disease	571.0 – 571.3	K70.0 – K70.9

Postcode of residence is a compulsory field in the VAED, so all hospital admissions were associated with a region. It should be noted that this analysis is based entirely on postcode of residence of the people hospitalised. This is unproblematic for the chronic disease analysis, but for the violence analysis it represents a shift from the approach undertaken for the work in Chapter 5 on assault, where the postcode of the incident was used. Thus the analysis for violence in this chapter is focussed on whether living in a postcode with higher densities of alcohol outlets places you at higher risk of being hospitalised for assault, but it does not (and cannot, due to data limitations) deal with the locality that the assault took place. Unpublished analyses of Victorian ambulance data suggest that more than half of assault victims are assaulted in their postcode of residence. A small proportion of admissions were for patients who report invalid postcodes or have no fixed abode (~1.5%), and these admissions were excluded from this analysis. There is no way to determine the precise relationship between the assaults examined in this chapter and those studied previously. However, it is clear that the assault-related hospitalisations represent a smaller and more serious category of assaults than those based on police record. For example, the number of hospitalisations for assault in the study period was about one-fifth of the number of police records of assault. Further, self-reported data suggests that fewer than 15% of assault victims require any medical attention at all (297) which, given that hospital admissions represent the most serious treatment outcome

²³ Note that alcoholic pancreatitis is not included, as it was not a specific code in ICD-9.

possible, is likely to mean that these data represent the most serious few percent of all assaults.

As the postcode data in the VAED relate to postcode of residence, it makes sense to undertake analyses using population-based rates rather than crude counts as used in Chapter 5 where the outcome was recorded based on the incident location.

Demographic data

The postcode population data were based on resident counts from census data from 1991, 1996, 2001 and 2006 (218, 324) as well as Estimated Residential Population figures for 2007 (380). Population data for 1994-1995, 1997-2000 and 2002-2005 were linearly interpolated. Very little demographic data is available longitudinally at the postcode level, so only the IRSED composite measure of socio-economic disadvantage used in the previous chapter is included as a control variable. This measure provides an overall estimate of the socio-economic disadvantage of an area, without introducing collinearity by including multiple measures of the same underlying construct (e.g. the proportion of people on low incomes and those with low educational attainment are highly correlated). Full details of the derivation of the IRSED have been published by the Australian Bureau of Statistics (286). IRSED scores for the non-Census years were linearly interpolated and, for 1994, 1995 and 2007 extrapolated based on a linear trend between the known data points. While this aggregated and estimated measure of socio-economic disadvantage is imprecise, it provides some control for the effects of changes over time in the socio-economic status of the postcodes in the study, which may be correlated with trends in the licensing environment.

Analysis

The dependent variables analysed in this study were the postcode level rates per 1,000 residents of hospital admissions with a primary diagnosis of assault or of a chronic alcohol-caused illness. Independent variables were residential population, number of packaged liquor outlets per 1,000 residents, number of on-premise outlets per 1,000 residents, number of general outlets per 1,000 residents and the IRSED index. Residential population was included as an independent variable to assess whether population growth (or decline) at a local level was related to per-capita hospitalisation rates.

The main aim of the study was to determine how outlet density at a postcode level was related to hospitalisation rates over a fourteen-year period. Time-series methods generally require many more time points, thus the analysis for this study was undertaken using the same cross-sectional time-series approach used in previous chapters. This study again utilised a fixed-effects model, with fixed effects for each postcode and each year included in the model. The incorporation of fixed-effects for the years as well as the geographical units ensures that the results of the model aren't unduly influenced by city-wide trends.

Because this study was based on geographical units, it was again necessary to control for spatial autocorrelation between postcodes. Thus, this study used a spatial fixed-effects modeling procedure based on maximum likelihood estimators to ensure that non-biased regression results were produced (204). As licence density of each of the three types tended to change together, initial models were estimated with each licence type entered separately, and then a final model was estimated with all three licence types included together.

7.3. Results

Descriptive statistics of the measures used in this study are presented in Table 19. A key concern with analyses such as these is that there is sufficient variation over time in the measures across the study units. While the overall levels of all of the measures (with the exception of the IRSED) increased substantially across the time-period studied, there was significant variation in the postcode-level trends, with a reasonable proportion of postcodes showing declines for each measure. This is true even for on-premise licence and chronic alcohol-caused hospitalisation rates, which both increased overall by more than 150%, with 7% and 20% respectively of postcodes recording declines.

Table 19 - Descriptive statistics of hospitalisation study measures

Variable	Mean	S.D.	Min	Max	Total net change	Proportion postcodes decreasing
Assault hospitalisations (per 1,000)	0.80	0.69	0	7.79	+43%	25%
Chronic alcohol hospitalisations (per 1,000)	1.36	1.74	0	16.79	+164%	20%
General licence rate (per 1,000)	0.44	1.51	0	22.74	+21%	37%
On-premise licence rate (per 1,000)	1.04	2.74	0	40.21	+154%	7%
Packaged licence rate (per 1,000)	0.29	0.22	0	1.04	+42%	21%
Index of Relative Socio-Economic Disadvantage (IRSED) (lower = disadvantaged)	1032.4	77.2	707.0	1162.5	-1%	51%
Population (/1,000)	15.6	10.1	0.4	56.0	+16%	17%

The results of the first set of fixed-effects models are presented in Table 20. This table includes the results for each of the licence types separately with assault hospitalisations as the outcome. All three licence categories were positively and significantly associated with assault hospitalisation rates. In particular each additional packaged licence was associated with an increase of 0.54 in the rate of assault hospitalisations. In contrast, the effects for general (0.13) and on-premise (0.06) licences were relatively small.

Table 20 - Fixed effects model results, relationship between assault hospitalisations and alcohol outlet density, 1994-2007, separate models for each licence category

Variable	General licences (pubs, nightclubs, etc)		Packaged licences (liquor stores, etc)		On-premise licences (restaurants, cafes, bars etc)	
	Effect size	p-value	Effect size	p-value	Effect size	p-value
Licence rate (per 1,000)	0.13	<0.01	0.54	<0.01	0.06	<0.01
Index of Relative Socio-Economic Disadvantage (IRSED) (lower = more disadvantaged)	-0.01	<0.01	-0.01	<0.01	-0.01	<0.01
Population (per 1,000)	-0.01	0.16	-0.01	0.11	-0.01	0.05

The results of the second set of fixed-effects models are presented in Table 21. This table includes the results for each of the licence types separately with chronic alcohol-related hospitalisations as the outcome. Again, all three licence categories are positively and significantly related to the outcome, with the effect size of packaged liquor outlets the largest.

Table 21 - Fixed effects model results, relationship between chronic hospitalisations and alcohol outlet density, 1994-2007, separate models for each licence category

Variable	General licences		Packaged licences		On-premise licences	
	Effect size	p-value	Effect size	p-value	Effect size	p-value
Licence rate (per 1,000)	0.12	<0.01	1.18	<0.01	0.08	<0.01
Index of Relative Socio-Economic Disadvantage (IRSED) (lower = more disadvantaged)	0.01	0.075	-0.01	0.026	0.01	0.21
Population (/ 1,000)	<0.01	0.298	0.01	0.088	<0.01	0.28

Table 22 includes the multivariate models, with all three licence types included together. In the first model, two of the outlet density variables remain significantly and positively related to the rate of assault hospitalisations, with effect-sizes of similar magnitude. An increase in the rate of general licences of 1 per 1,000 residents is associated over time with an increase in assault hospitalisations of 0.16 per 1,000 residents, while a unit increase in the packaged licence rate is associated with an increase of 0.21 in the assault rate. From the overall mean levels of the licensing and hospitalisation variables, this implies that an increase of 10% in the rate of general licences in an area would increase hospitalisation rates for assault by 0.6%. Similarly, a 10% increase in packaged liquor licences would increase assault rates by 0.8%. It is also worth noting the negative relationship between the IRSED index and rates of assault hospitalisations, implying that assault rates have decreased in areas where socio-economic conditions have improved.

Table 22 - Fixed effects model results, relationship between assault and chronic alcohol-caused hospital admissions and alcohol outlet density (all outlet types included), 1994-2007

Variable	Assault hospitalisations		Chronic alcohol-caused hospitalisations	
	Effect size	p-value	Effect size	p-value
General licence rate (per 1,000)	0.16	<0.01	-0.06	0.22
On-premise licence rate (per 1,000)	-0.01	0.85	0.07	0.01
Packaged licence rate (per 1,000)	0.21	<0.01	0.87	<0.01
Index of Relative Socio-Economic Disadvantage (IRSED)	-0.01	<0.01	0.01	0.111
Population (/ 1,000)	-0.01	0.38	0.01	0.09

The results of the second model include significant positive associations of on-premise outlet density and packaged outlet density with rates of chronic alcohol-caused hospitalisations, with the effect of general licences no longer significant when controlling for the other licence categories. Packaged liquor outlets remained the most influential, with an increase of 1 packaged outlet per 1,000 residents in a neighbourhood associated with an increase in the rate of alcohol-caused chronic disease of 0.874. While on-premise outlet density was significant, the associated effect was much smaller, at 0.071. As above, starting from the overall mean levels of outlet densities (from Table 19), these coefficients imply that a 10% increase in the rate of packaged licences would increase chronic alcohol-caused hospitalisations by 1.9%, while a 10% increase in on-premise outlets would increase chronic alcohol-caused disease by 0.5%. None of the other independent variables were significantly related to chronic alcohol-caused hospital admissions.

7.4. Discussion

The results of this study provide partial support to the hypothesis outlined above. As expected, the density of general (pub/hotel) licences was significantly related to rates of assault and packaged liquor density was related to chronic disease. These results are broadly compatible with Freisthler's routine activity theory, with outlets associated with heavy on-premise drinking (general licences) linked to violence, while outlets where the cheapest alcohol is available associated with diseases related to long-term heavy drinking. However, the significant relationships between packaged outlets and violence and between on-premise outlets and chronic disease were unexpected and don't fit neatly into a simple theoretical explanation.

Effects on violence

The density of general and packaged liquor outlets were both positively associated with rates of assault hospital admissions, with similar effect sizes. While these effect sizes were relatively small (mean elasticities of 0.06 and 0.08 respectively), it is worth noting that this study is dealing with some of the most severe violence, which results in admission to hospital (note that this does not include victims who are treated only in the emergency department). According to previous survey research, only 12% of assault victims receive any medical treatment at all, with the proportion resulting in hospitalisation likely to be substantially lower (297). The relationship between general licence density and violence was expected, and reinforces the previous results found using police data (Chapter 5). Increasing the

density of places where drinking is the main activity is likely to increase the interactions between disinhibited people and thus increase the risk of violence. While the current study can't disentangle the precise mechanism linking violence and general licence density, these results are also consistent with Gruenewald's assortative drinking extension of routine activities (73).

Contrary to the study's hypotheses, packaged liquor was also associated with violence rates. While this wasn't expected, it does not necessarily contradict Freisthler's interpretation of routine activities theory, which would predict packaged liquor density would be associated with higher rates of violence in the home. As the outcome measure for this study doesn't distinguish between incidents of domestic and public violence, it is possible that the general licence effect relates to public assaults while the packaged licence effect relates to domestic assaults. There is some evidence from the previous chapter that packaged liquor and domestic violence are related, although this is not a consistent finding (153). This study is not the first to find a longitudinal relationship between packaged liquor outlets and general violence rates (e.g. 122, Chapter 5), although the mechanism for this relationship remains unclear (334). There has been little attention paid to domestic violence. Some authors from the U.S. have highlighted the link between packaged liquor, drug markets and other risky behaviours such as gang activity (107, 157), which may explain the relationship in cities in the U.S. Recent Australian concerns about late-trading packaged liquor outlets (381) and the use in Australia and elsewhere of off-premise alcohol to 'preload' (382) provide some pointers to possible explanations of these relationships, but there has been little research into these kinds of issues in an Australian context, and very little is known about packaged liquor outlets that could provide insight into the specifics of their relationship to public violence.

Effects on chronic disease

As predicted in this study's hypothesis, there was a strong positive association between packaged outlet density and rates of alcohol-caused chronic disease. This relationship fits with the idea that different types of alcohol outlets in the local environment impact on routine drinking activities, with high densities of packaged liquor providing a cheap source of alcohol and resulting in higher levels of drinking. Based on the survey data (which, as discussed, should be treated with caution) presented earlier in this thesis, there is some evidence that the marked increase in alcohol availability in Victoria in recent years has not greatly altered consumption at the population level. However, the results of this study demonstrate quite

strong associations between increases in packaged liquor availability and chronic alcohol-related disease, which other research has shown occur disproportionately amongst disadvantaged and vulnerable sections of the population (383). Thus, while the data in this study cannot be used to assess the kinds of people likely to be affected by the association between packaged liquor and chronic disease, these results combined with general population data are suggestive of a disproportionate effect on vulnerable groups (86).

The small but significant relationship between on-premise alcohol availability and chronic disease is harder to explain. As discussed earlier, on-premise licences incorporate a broad range of venues: predominantly cafes and restaurants, but also including some bars and nightclubs, which makes it particularly difficult to develop a clear explanation for the relationship found in this study. A relationship between restaurants and chronic alcohol-related disease is counter-intuitive. However, there is some evidence that heavy drinkers frequently drink in bars and that bar patronage is a predictor of heavy drinking behaviour (e.g. 384). Thus, the positive effect found here may be related to the density of bars in particular, although the data available for this study makes it impossible to assess the relative contribution of bars and restaurants.

It is worth noting that this study only evaluates the concurrent effects of availability on chronic disease. Given the kinds of conditions included in this category (e.g. liver cirrhosis), it is likely that there is also a significant lagged effect. That is, changes in alcohol availability in one year will most likely affect rates of chronic disease over a period of time longer than the single year being considered. Indeed, as discussed above, time-series research assessing the link between alcohol consumption and liver cirrhosis suggests that roughly half of the effect is likely to occur beyond the current year. Thus, the findings presented here should be considered a lower estimate of the actual effects on chronic disease, which may be as much as twice the size reported here.

Limitations

The major limitations of the current study relate to the broad data categories used in the analysis. In particular, the measures of alcohol outlet density are crude, not taking into account variation in premises and availability within licence types. As discussed, this is a particular problem for on-premise licences, which incorporate a broad range of venue types, but is also problematic for general and packaged liquor outlets, which can vary significantly

in size, turnover and trading hours. A further limitation of the current study is the use of only a broad index of socio-economic disadvantage to control for changes at the neighbourhood level beyond the liquor licensing environment. Thus, for example, changes in the broader retail and land use environment or in the demographic profile of an area, which have previously been linked with alcohol-related problems (80), are not controlled for in the current analysis. The current study is also limited by the use of only a single control variable (socio-economic disadvantage) at the local level. It is plausible that changes to, for example, the age structure of populations at the local level over the time-period studies will have influenced rates of the two outcome variables examined here. Unfortunately, more detailed demographic data were unavailable for inclusion in this study, and future work is necessary to test their influence on these findings. Thus, the results presented here provide only a broad picture of the relationship between the density of alcohol outlets and violence and chronic disease. Further data, on alcohol sales, opening hours, capacity and venue style as well as more detailed socio-demographic data could provide further insight into these relationships.

In addition, an underlying assumption of the current study is that alcohol tends to be purchased and consumed by people within the postcode in which they live. While this is clearly not always the case, no data is available to estimate the extent to which this issue affects the results of the analysis presented here.

Policy implications

The limitations discussed above mean that the results of this study need to be treated with caution. However, the results presented here provide further longitudinal evidence that alcohol-related problems in Melbourne are associated with the density of alcohol outlets. Of particular note are the findings for packaged liquor outlets, which were positively associated with both assaults and chronic alcohol-caused disease. The current policy emphasis in Victoria is on entertainment districts and general licences (e.g. 331), which are again found to be related to violence in this study, but there has been little attention paid to the effects of packaged liquor outlets on alcohol-related problems. These results suggest that further focus on packaged liquor is required, both in terms of future research to determine the mechanisms for the observed relationships and in terms of regulatory attention.

Chapter 8. Socio-economic inequalities and the distribution of alcohol outlets²⁴

8.1. Introduction

There has been substantial international research highlighting the significant socio-economic inequalities in health outcomes in developed countries (178). Within Australia, these inequalities are considerable, with mortality rates significantly higher amongst disadvantaged communities across a range of age groups and causes of death (385). The causes of these inequalities are varied and complex (179), but it is clear that risky health behaviours contribute to them, with notable socio-economic gradients found for health risk factors such as obesity and smoking internationally (386, 387) and within Australia (388, 389). The situation for alcohol is less straightforward. The relationship between socio-economic disadvantage and drinking pattern varies substantially between countries and sub-populations (184, 186). In Australia, there is some evidence that males from lower socio-economic areas are more likely to drink at risky levels (187), although this is not a consistent finding (188). Despite the varied findings on the relationship between socio-economic disadvantage and drinking, there is clearer evidence that less advantaged people experience a greater burden of alcohol-related harm. For example, research in Finland found that for a given level of drinking, poorer Finns were around twice as likely to die or be hospitalised due to alcohol (390). Higher rates of alcohol-related mortality among disadvantaged sections of the population have been found in a number of countries (e.g. 391, 392, 393), and a recent study in Australia suggested blue-collar workers had a liver cirrhosis mortality rate more than twice that of white-collar workers (383).

Given the disparities in harm experienced, there is clear evidence that alcohol is a substantial contributor to health inequalities in many parts of the world, including Australia.

²⁴ This chapter draws on work published in: Livingston, M., The social gradient of alcohol availability in Victoria, Australia. *Australian and New Zealand Journal of Public Health*, In press.

Environmental impacts on inequalities

Many researchers have looked to environmental factors to explain the disparities in health observed across socio-economic groups (e.g. 394). This is particularly true when the focus is on health risk behaviours.

For example, a range of studies have examined the association between socio-economic deprivation and access to healthy food. In the U.S., Walker et al. (183) reviewed 31 studies examining food access. They found that studies generally identified higher densities of fast food outlets and less access to supermarkets in disadvantaged neighbourhoods. The U.S. studies focus particularly on ethnicity, finding that predominantly black neighbourhoods have the least access to healthy food. Similar work in the U.S. has demonstrated lower access to facilities related to physical activity in disadvantaged neighbourhoods (395). Findings outside of the U.S. have been more mixed (396). For example, a recent study in New Zealand demonstrated higher densities of fast food outlets in deprived neighbourhoods, but similarly high rates of access to healthy foods in these neighbourhoods (397). In Australia, a number of studies have found higher access to fast food outlets in socio-economic disadvantaged neighbourhoods, including three studies from Victoria (181, 182, 398).

Similar analyses have been undertaken examining access to attempt to explain socio-economic disparities in smoking rates. These studies have thus far been limited to the U.S., but have found support for the argument that the local environment contributes to health inequalities. Multiple studies have found evidence linking rates of smoking to tobacco outlet densities (53, 57, 399) and it has been shown repeatedly that tobacco outlets are more prevalent in poor or minority neighbourhoods (55, 180, 399).

Previous studies of alcohol outlet distributions

In the alcohol field, a number of researchers have examined whether the distribution of alcohol outlets is related to social class to assess whether the alcohol environment may contribute to socio-economic inequalities in alcohol-related harm. This literature was summarised in Section 1.2 of this thesis and will be only briefly discussed here. A number of studies examining the distribution of alcohol outlets have been undertaken in the U.S., with their scope ranging from single cities (190, 191) to studies within states (102) to comprehensive national studies (194, 195). These studies have uniformly found that

packaged liquor stores in the U.S. are concentrated within poor neighbourhoods with high minority populations. The one study to make use of non-urban data suggested that this effect was predominantly an urban one, with liquor outlets distributed more evenly in rural and regional areas (194). Little work has been undertaken in this area outside of the U.S. In New Zealand, two separate national studies found similar inequalities, with alcohol outlets of all types clustered within socio-economically deprived communities (196, 197). The only other study in this field was undertaken in Glasgow and produced much less clear results, with the areas having the highest outlet densities being relatively deprived, but a consistent social gradient not evident (198). This work is still in its early stages. Thus far there have been no studies of the distribution of alcohol outlets in Australia, and no studies examining how changes in alcohol availability play out across different kinds of neighbourhoods.

Alcohol outlet effects

While the research outlined above is still developing, there is good reason to focus on the equity of how alcohol outlets are distributed, as there is strong evidence linking the distribution of outlets to the distribution of alcohol-related harm. This evidence has been discussed and developed across this thesis and will not be discussed in depth here. In brief, studies have identified relationships between alcohol outlet density and a range of negative outcomes related to alcohol including heavy drinking, violence, accidents and injury, domestic violence, reduced neighbourhood amenity, sexually transmitted disease and chronic disease. For a more detailed summary of this literature, see Chapter 1. It is worth noting that the specific effects of alcohol outlets on harm types vary substantially by type of outlet, type of harm and the setting of the study (48). The studies on data from Melbourne presented in this thesis have found particularly strong effects for general (hotel) outlets and packaged liquor outlets. For example, in the longitudinal study presented in Chapter 5, hotel numbers were linked to rates of assault in inner-city areas, while packaged liquor outlets were associated with assaults in the suburbs. The subsequent work presented in Chapter 6 and Chapter 7 found significant relationships between packaged liquor, domestic violence and alcohol-related chronic disease over time. Thus, data from Victoria demonstrate significant relationships between alcohol outlet distributions and harm rates at the local level. This suggests that research into how these outlets are distributed across socio-economic areas may provide some useful insights into the role of alcohol availability in perpetuating health inequalities.

The current study

The work presented in this chapter has been undertaken in two parts: firstly examining the distribution of alcohol outlets in Victoria at a single point in time (the year 2006), and secondly examining how this distribution has changed over time, spanning a 15 year period (1991-2006) that saw substantial liberalisation in Victorian liquor licensing (see Figure 1). The work presented here is the first to examine the distribution of alcohol outlets in an Australian context, and the first anywhere to explore how changes in alcohol availability over time affect the socio-economic distribution of alcohol availability.

8.2. Methods

Geocoding

For the purposes of this study, which aimed to examine these relationships across urban and rural Victoria, postcodes were considered inappropriate units. Rural and regional postcodes are often geographically large, spanning multiple small towns and not necessarily representing meaningful communities. Furthermore, in urban areas, postcodes can contain diverse socio-economic sub-areas and for the cross-sectional analysis a finer grained geographical approach was desired. In addition, as has been discussed throughout this thesis, there is limited longitudinal data available at the postcode level. To facilitate the use of non-postcode geographical units, the liquor licensing data for 1991, 1996, 2001 and 2006 were geocoded based on street address information included in the liquor licensing data used across this thesis.

The data were geocoded by MapData Sciences Australia, a commercial spatial data consulting company with expertise in the area. The initial geocoding run found exact address matches for 73.7%, street-level matches for 20.3% and suburb-level matches for 6.0% of all outlets. To improve precision, the 8,142 addresses that were matched only at the suburb level were manually checked and altered using internet searches and historical phone books. This improved geocoding success rate substantially, resulting in 79.0% of addresses matched exactly, 20.5% at the street level and just 0.5% at the suburb level (Table 23).

Table 23 - Liquor licensing geocoding accuracy

Match level	First pass	Second pass
Exact	73.7%	79.0%
Street level	20.3%	20.5%
Suburb level	6.0%	0.5%

Geocoding accuracy varied substantially across licence types (Table 24), with general licences more likely than packaged or on-premise licences to be accurate only to the street level.

Table 24 - Liquor licensing geocoding accuracy by licence type

Match level	General licences	Packaged licences	On-premise licences
Exact	74.4%	86.1%	88.1%
Street level	25.1%	13.3%	11.4%
Suburb level	0.5%	0.6%	0.5%

Similarly, there was substantial variation in geocoding accuracy by location, with rural licences substantially less likely to be matched at the exact address level (Table 25).

Table 25 - Liquor licensing geocoding accuracy by rurality

Match level	Metropolitan	Regional/rural
Exact	89.1%	61.8%
Street level	10.7%	37.2%
Suburb level	0.2%	1.1%

Overall, the geocoding process undertaken has produced results consistent with many other liquor licensing geocoding studies. For example, work undertaken in New South Wales successfully geocoded only 90% of outlets at the exact or street-level, with 10% coded at the less precise suburb level (121). In New Zealand, studies on alcohol availability have successfully geocoded between 73% and 87% of outlets (95, 197), while studies in the U.S. typically report higher match rates (up to 99%), although these studies are generally in urban settings (400).

Geographic units

Initial analyses were based on data from 2006, to allow for matching with data collected in the national Census that year. All data were aggregated to the smallest possible geographical unit, the Census Collection District (CD). In general, CDs contain around 500 residents, varying substantially in geographic size depending on population density.

Geographic units were classified as either metropolitan or regional based on the remoteness classification contained within the Australian Bureau of Statistics Australian Standard Geographical Classification System (ASGC) (203). Within the ASGC, collection districts are grouped into five categories: major cities, inner regional, outer regional, remote and very remote. For ease of analysis, the 22 'remote' CDs, 688 'outer regional' CDs and 2,135 'inner regional' CDs were combined into a single 'regional/remote' group, with the remaining 6,453 CDs in the 'Major cities' group (basically made up of Melbourne and Geelong).

Subsequent analyses made use of data from four national Censuses, 1991, 1996, 2001 and 2006. Again, analyses were based on CDs. However, CDs vary from Census to Census, so these analyses were limited to comparing aggregations of CDs (into deciles of disadvantage) over time. Unit level longitudinal analysis was undertaken with 2006 Statistical Local Areas, larger geographic units for which ongoing Census data are available. While the analyses in the previous chapters relied on postcodes, SLAs provide more reasonable approximations for communities in non-urban areas and have thus been used here. Using 2006 SLA boundaries, Victoria is divided into 210 distinct regions. Due to low populations, nine of these SLAs were excluded from analyses (including offshore islands, ski resorts and migratory areas), leaving 201 units for longitudinal analysis.

Data

Licensing data were based on unit level data on all active licences as at June of each study year (1991, 1996, 2001 and 2006), provided by Responsible Alcohol Victoria. Outlet densities were calculated for each of the three licence categories in two ways: per-capita and per square kilometre. The use of both methods allows some examination of whether any associations found between outlet density and socio-economic disadvantage were due to the way in which outlet density was calculated.

Four main demographic variables were examined in relation to alcohol availability. Firstly, the ABS produced Socio-Economic Index for Areas (SEIFA) index of relative socio-economic disadvantage was used as a composite measure of local area disadvantage (364). This index was used rather than individual markers of disadvantage (e.g. unemployment, income, education levels etc) due to the high correlations between these single measures. Collection Districts were assigned to deciles of socio-economic disadvantage based on cut-offs produced by the ABS using the total Australian population. SEIFA disadvantage indices have been produced at each of the last four Censuses and, despite different underlying methodologies, comparisons of deciles across time is appropriate (364). A visual representation of the distribution of socio-economic disadvantage across Victoria is presented in Figure 15 and Figure 16, which map the deciles of socio-economic disadvantage in 2006. Blank areas on the maps represent Census Collection Districts that had too few residents for a SEIFA disadvantage score to be derived.

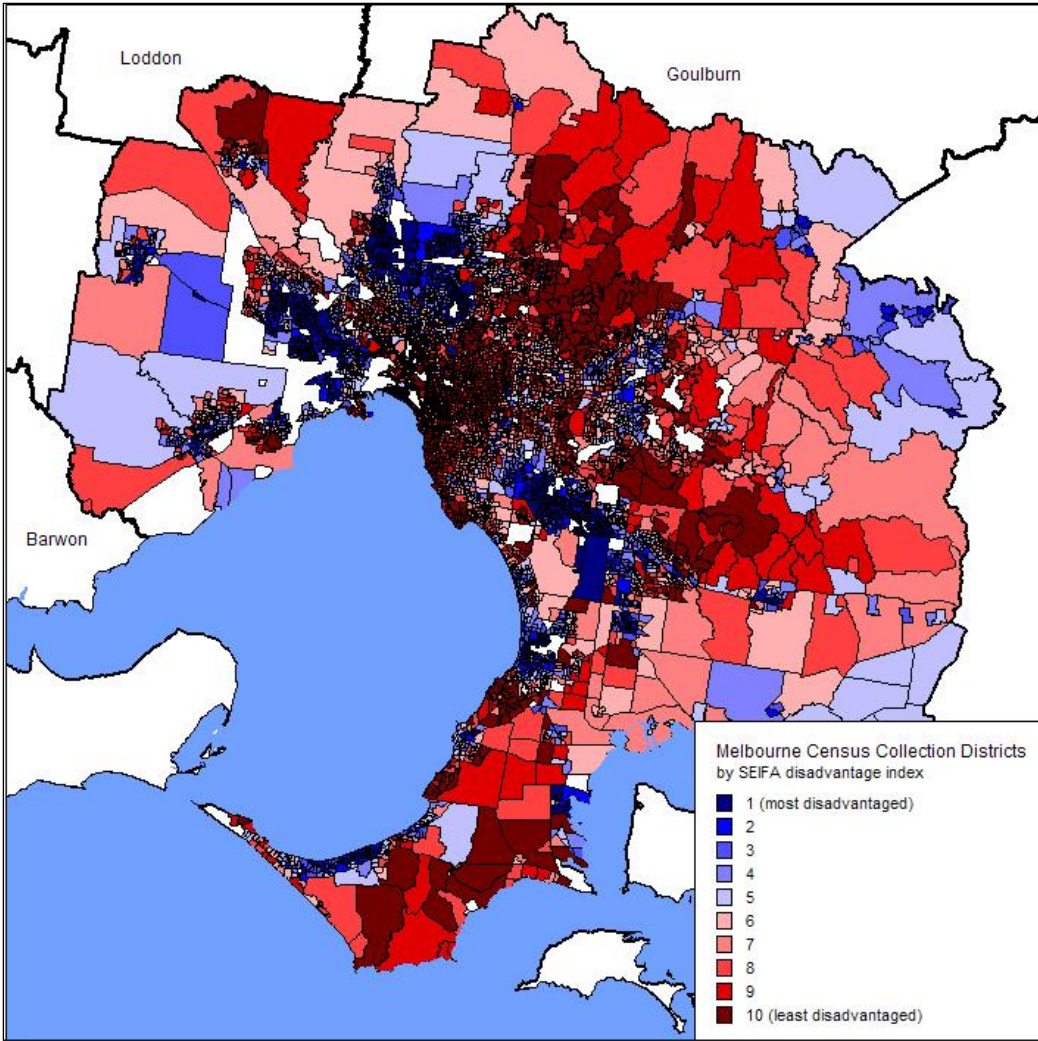


Figure 15 - Melbourne Census Collection Districts, mapped by decile of SEIFA disadvantage, 2006

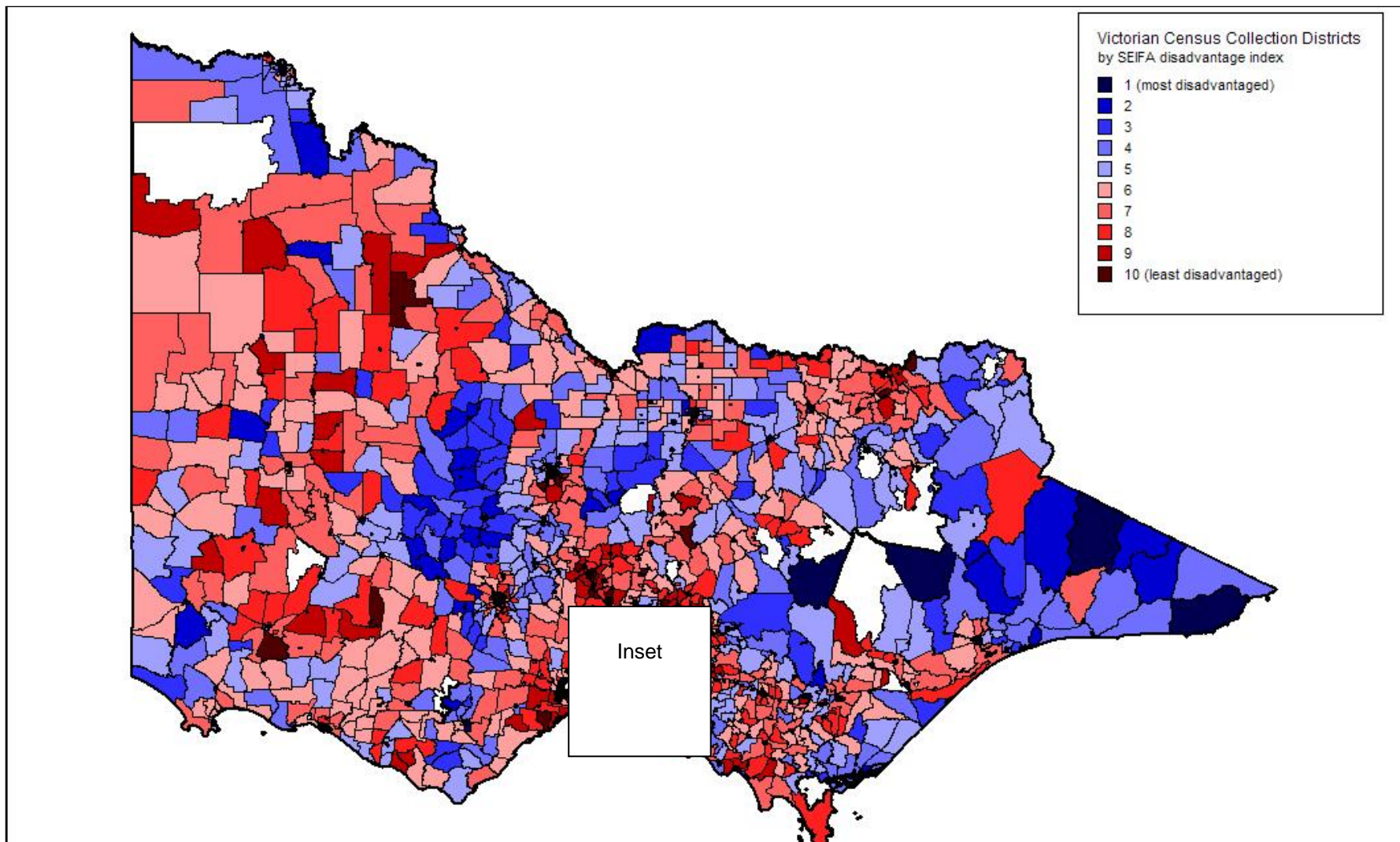


Figure 16 - Victorian Census Collection Districts, mapped by decile of SEIFA disadvantage, 2006

In addition to socio-economic disadvantage, median age, proportion of residents who were male and the proportion of people counted within the CD on Census night who were visitors from elsewhere were included in more detailed analyses to assess whether alcohol availability was related to the age and sex structure of the population or to tourism in the area. Where available, these data were sourced from the Census community profiles (326), with some of the data from the 1991 Census sourced via a specific data request to the Australian Bureau of Statistics.

Analysis

As mentioned above, due to substantial differences in the meaning of accessibility between urban and rural areas and to imprecision in geocoding at a regional level (see Table 25 and (197)), all analyses were conducted separately for urban and regional areas.

For the initial analyses, Census collection districts were grouped into ten groups, based on the decile of socio-economic disadvantage. Thus, the state of Victoria was basically collapsed into 10 areas based on disadvantage, from decile 1 (most disadvantaged) to decile 10 (least disadvantaged). Populations, licence numbers and other descriptive statistics were aggregated for these 10 groups of CDs to provide average outlet densities for people living in each decile. These analyses were undertaken using a combination of MapInfo and Microsoft Excel. Initial analyses using this method focussed on 2006 data, with simple linear regression with outlet density as the dependent variable and decile as the independent variable used to determine whether socio-economic gradients were significant. This data aggregation approach was also taken for each of the four years being examined to allow for a comparison at the aggregate CD level across time. These longitudinal comparisons were undertaken descriptively.

To delve more deeply into the cross-sectional associations between socio-demographics and alcohol availability in 2006, regression models were developed using the 9,095 CDs as the study units, with licence counts as the dependent variables and the population size, area, SEIFA decile, median age, proportion male and proportion of visitors as independent variables. Due to the nature of the outcome variables (counts of outlets), negative binomial regression models were utilised.

To provide more robust models of change over time, fixed effects models using data from 201 Statistical Local Areas were developed. These models assess which of the independent variables were associated with changes in alcohol availability over time, providing an assessment of whether changes in socio-economic disadvantage affect the number of outlets in an area. Similar control variables to the cross-sectional analyses were used, with the age variable changed from median age to the proportion of the population aged between 15 and 34 due to data availability. As with the cross-sectional models, a negative binomial regression approach was undertaken.

Tests of spatial autocorrelation found no significant spatial correlation between the residuals of the regression models fitted, thus the models presented here do not include spatial controls.

8.3. Results

Cross-sectional results

Metropolitan areas

Collection district socio-demographic data aggregated to SEIFA deciles across urban Victoria are presented in Table 26. Unsurprisingly, CD-level unemployment rate declines consistently from the most disadvantaged group of CDs (decile 1) to the least disadvantaged CDs (decile 10). Similarly, median income varies in the expected direction, with higher income in less disadvantaged CDs. Notably, population density was substantially higher in disadvantaged CDs compared with those in the less disadvantaged deciles.

Table 26 - Socio-demographic information by SEIFA decile of socio-economic disadvantage, metropolitan areas, Victoria, 2006

SEIFA decile	N	Median age	Unemployment rate	Median income	Population	Area (sq km)	Population per sq. km
1 (most disadvantaged)	622	36.8	12.75	293.2	352,568	202	1,749
2	498	37.5	8.44	363.2	284,780	172	1,655
3	496	36.2	6.92	408.9	286,805	208	1,377
4	556	35.9	6.14	439.4	340,056	248	1,369
5	576	36.4	5.33	472.6	332,383	359	926
6	577	36.7	4.85	491.1	338,524	540	627
7	647	36.4	4.42	524.3	379,403	442	859
8	712	36.5	3.95	564.2	411,968	508	811
9	776	36.9	3.66	601.5	454,519	517	880
10 (least disadvantaged)	842	38.1	3.01	689.0	483,803	661	732

Data on alcohol outlet density by SEIFA decile are presented in Table 27. Outlet density is measured in two ways: per 1,000 residents and per 10 square kilometres. The relationship between socio-economic disadvantage and alcohol availability was tested using simple linear regression with decile as the independent variable and the measures of outlet density as dependent variables.

Table 27 - Alcohol outlet density by SEIFA decile of socio-economic disadvantage, metropolitan areas, Victoria, 2006

Decile	Licences per 1,000 residents			Licences per 10 square kilometres		
	General	Packaged	On-premise	General	Packaged	On-premise
1	0.14	0.40	0.60	2.43	7.04	10.51
2	0.18	0.45	0.89	2.96	7.50	14.71
3	0.28	0.36	1.06	3.79	4.95	14.55
4	0.30	0.34	1.17	4.15	4.67	16.03
5	0.29	0.34	1.13	2.70	3.17	10.47
6	0.36	0.33	1.45	2.28	2.07	9.07
7	0.27	0.28	1.03	2.31	2.45	8.81
8	0.28	0.27	1.01	2.28	2.22	8.23
9	0.31	0.24	1.17	2.73	2.13	10.26
10	0.27	0.21	0.97	2.01	1.57	7.13
Linear regression coefficient	0.01	-0.02	0.03	-0.11	-0.66	-0.70
P-value	0.07	<0.01	0.23	0.14	<0.01	0.03

Only packaged liquor availability had a significant socio-economic gradient across both measures of alcohol outlet density, with substantially higher densities of packaged outlets in more disadvantaged areas regardless of the measure used. Based on per-capita outlet density, people living in the most disadvantaged areas were exposed to almost twice as many packaged outlets as those in the least disadvantaged. Using an area-based measure, this gradient was even steeper, with 4.5 times as many outlets per square kilometre in the poorest areas as in the richest areas.

To overcome the problem of using two different denominators in the rates presented above, negative binomial models were developed using the absolute number of alcohol outlets as the outcome variable and controlling for both population and CD area (Table 28). In addition, three further control variables (median age, a measure of tourism and the proportion of the population that were male) were incorporated to ensure that the relationship between socio-economic disadvantage and alcohol availability was not confounded by other factors. Thus, the models below provide more robust estimates of the relationship between socio-economic disadvantage and alcohol outlet density.

Table 28 - Negative binomial regression models of the association between alcohol outlet numbers and socio-economic disadvantage, metropolitan Victoria, 2006

Variable	General		Packaged		On-premise	
	Coef	P-value	Coef	P-value	Coef	P-value
IRSED decile (lower score = disadvantaged)	0.03	0.05	-0.07	<0.01	0.04	0.01
Population (1,000s)	-1.89	<0.01	-0.19	0.24	-1.41	<0.01
Area (square kms)	0.03	0.04	0.01	0.78	0.03	0.03
% visitors	0.09	<0.01	0.03	<0.01	0.11	<0.01
% male	-0.01	0.89	-0.02	0.14	-0.03	0.02
Median age	-0.46	<0.01	0.01	0.03	-0.01	0.08

The results of the models show varying relationships between socio-economic status and alcohol availability, with general and on-premise licences more common in advantaged areas, while packaged licences were more common in disadvantaged areas. The model coefficients represent the percentage increase in the number of outlets likely in an area for a unit increase in the relevant independent variable. For example, an increase in the decile of disadvantage of 1 unit (i.e. to a more advantaged decile) is associated with an increase of 3.4% in general outlets and 4.4% in on-premise outlets and with a decline of 7.0% in packaged outlets.

The proportion of the counted population that were visitors from elsewhere (i.e. our measure of tourism) was positively associated with all types of alcohol outlet, as was the geographical size of the CD. Other measures produced mixed results, with on-premise and general licences more common in CDs with smaller populations, while packaged licences were more common in high population CDs. Gender had little relationship with alcohol availability, while CDs with younger populations had more general licences and fewer packaged licences.

Regional and remote areas

Socio-demographic data for non-metropolitan regions are presented in Table 29. The basic patterns are similar to the metropolitan data with unemployment and population density higher in disadvantaged deciles and income lower. Compared with the metropolitan data, rural and regional CDs have slightly older populations across the board and generally lower incomes.

Table 29 - Socio-demographic information by IRSED decile of socio-economic disadvantage, non-metropolitan areas, Victoria, 2006

IRSED decile	N	Median age	Unemployment rate	Median income	Population	Area (sq km)	Population per sq. km
1 (most disadvantaged)	287	39.5	11.6	321.4	136,204	5,472	24.9
2	412	42.0	7.6	356.8	187,806	11,221	16.7
3	413	40.8	6.1	383.2	187,299	16,579	11.3
4	354	40.6	5.1	411.3	160,655	29,234	5.5
5	333	40.1	4.6	427.8	146,517	31,835	4.6
6	333	39.1	3.8	457.9	135,182	44,091	3.1
7	263	39.7	3.4	469.0	109,689	39,158	2.8
8	197	38.6	3.2	495.5	80,760	21,128	3.8
9	134	37.3	2.9	544.4	64,257	10,376	6.2
10 (least disadvantaged)	67	38.0	2.5	590.3	32,878	1,987	16.5

As with the metropolitan data, regional and remote alcohol availability was examined using both per-capita and per-area measures (Table 30).

Table 30 - Alcohol outlet density by IRSED decile of socio-economic disadvantage, non-metropolitan areas, Victoria, 2006

IRSED Decile	Licences per 1,000 residents			Licences per 10 square kilometres		
	General	Packaged	On-premise	General	Packaged	On-premise
1 (most disadvantaged)	0.73	0.57	0.81	0.18	0.14	0.20
2	1.25	0.77	1.26	0.21	0.13	0.21
3	1.07	0.64	1.58	0.12	0.07	0.18
4	0.76	0.37	0.97	0.04	0.02	0.05
5	0.73	0.41	0.98	0.03	0.02	0.04
6	0.44	0.28	0.96	0.01	0.01	0.03
7	0.45	0.32	0.88	0.01	0.01	0.02
8	0.28	0.22	0.61	0.01	0.01	0.02
9	0.33	0.22	0.79	0.02	0.01	0.05
10 (least disadvantaged)	0.18	0.09	0.67	0.03	0.02	0.11
Linear regression coefficient	-0.10	-0.06	-0.06	-0.02	-0.01	-0.02
P-value	<0.01	<0.01	0.06	0.04	<0.01	0.03

A strong socio-economic gradient in alcohol availability was evident across all licence types in rural and regional areas, regardless of the density measure utilised. For example, using a per-capita measure, people living in the most disadvantaged decile had more than six times as many packaged liquor outlets and four times as many general outlets in their neighbourhoods than those in the most advantaged decile. These ratios were even higher when using an area-based measure of outlet density.

As with the metropolitan data described above, negative binomial models were produced to more robustly assess the relationship between socio-economic disadvantage and alcohol availability (see Table 31).

Table 31 - Negative binomial models of the association between alcohol outlet numbers and socio-economic disadvantage, non-metropolitan Victoria, 2006

	General		Packaged		On-premise	
	Coef	P-value	Coef	P-value	Coef	P-value
IRSED Decile (lower = disadvantaged)	-0.17	<0.01	-0.16	<0.01	-0.02	0.49
Population (1,000s)	0.18	0.40	0.72	0.01	0.52	0.04
Area (square kms)	<0.01	0.99	<0.01	0.22	-0.001	<0.01
% visitors	0.05	<0.01	0.05	<0.01	0.13	<0.01
% male	0.01	0.39	-0.01	0.90	-0.01	0.63
Median age	0.03	<0.01	0.04	<0.01	0.04	<0.01

In regional and remote areas of Victoria, both general outlets and packaged outlets were substantially more likely to be located in disadvantaged CDs. There was a non-significant social gradient for on-premise licences. Effect sizes were substantially larger than in metropolitan areas with 17.3% and 15.8% decreases in general and packaged outlets associated with each decile of disadvantage.

As with the metropolitan models, tourism was significantly associated with alcohol availability. Population was generally positively associated with outlet numbers (except for general outlets), while CDs with higher median ages had higher numbers of all outlet types.

Summarising the cross-sectional results

The most consistent finding across metropolitan and non-metropolitan areas of Victoria is that people living in disadvantaged areas are disproportionately exposed to packaged liquor outlets. This was true across all the analytical approaches undertaken, irrespective of the denominator used in the descriptive analysis and across both sets of regression models. This is illustrated in Figure 17, which plots the socio-economic gradient of packaged outlet density on a per-capita basis for metropolitan and non-metropolitan CDs.

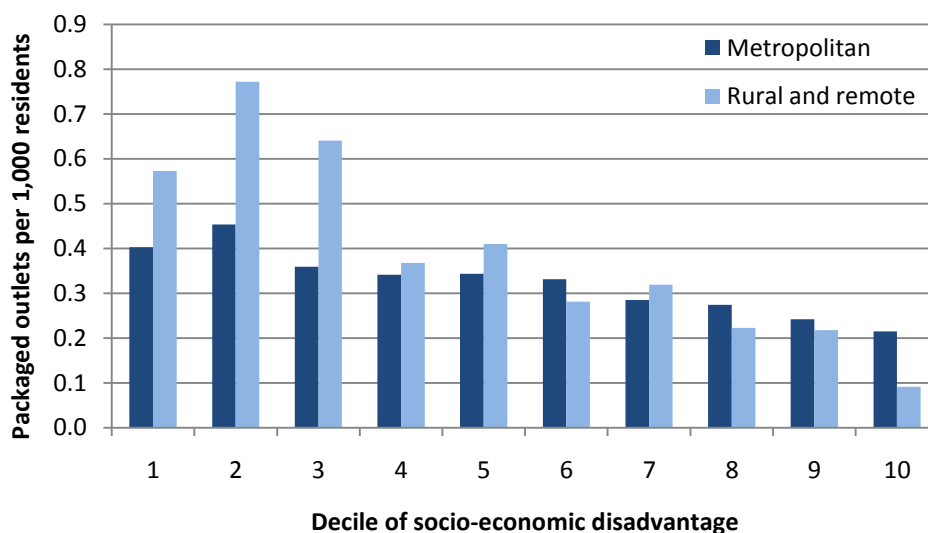


Figure 17 - Metropolitan and non-metropolitan packaged outlet density by decile of socio-economic disadvantage, 2006

In contrast, the results for on-premise and general licences were more mixed. Broadly speaking, these outlets were slightly more concentrated in areas of socio-economic advantage in urban parts of Victoria and were clustered in more disadvantaged parts of rural and regional Victoria.

Longitudinal results

Metropolitan areas

Figure 18 presents the broad changes between 1991 and 2006 in the socio-economic gradient of alcohol availability across the four licence types examined in this study.

With the exception of packaged liquor outlets, inequalities in alcohol availability have substantially reduced over the period of the study. In 1991, all three categories of alcohol outlets were more common in disadvantaged areas, while by 2006, rates of on-premise and general outlets had flattened out across the deciles. The socio-economic gradient of the density of general licences changed the most, from highly skewed towards disadvantaged neighbourhoods to the reverse.

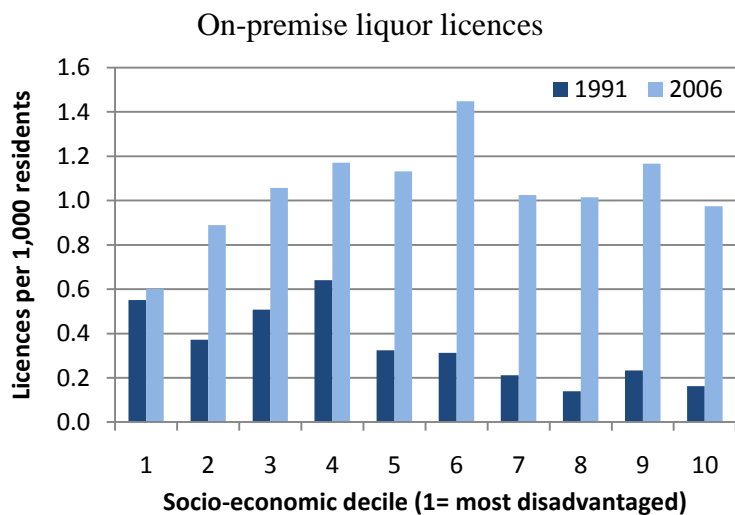
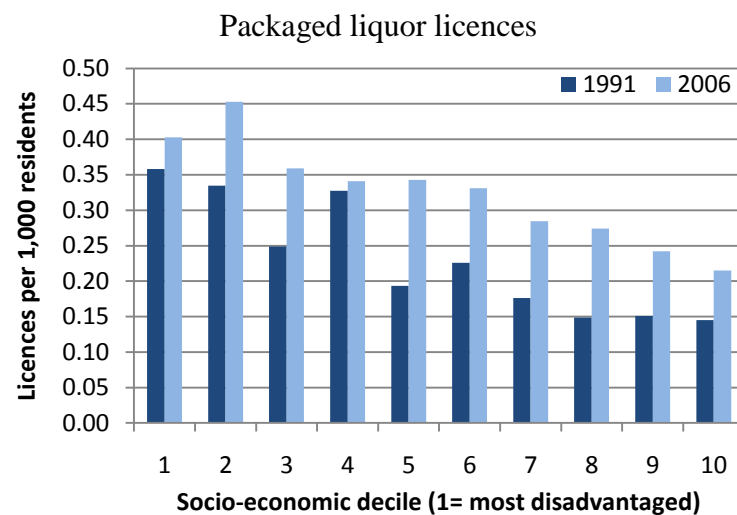
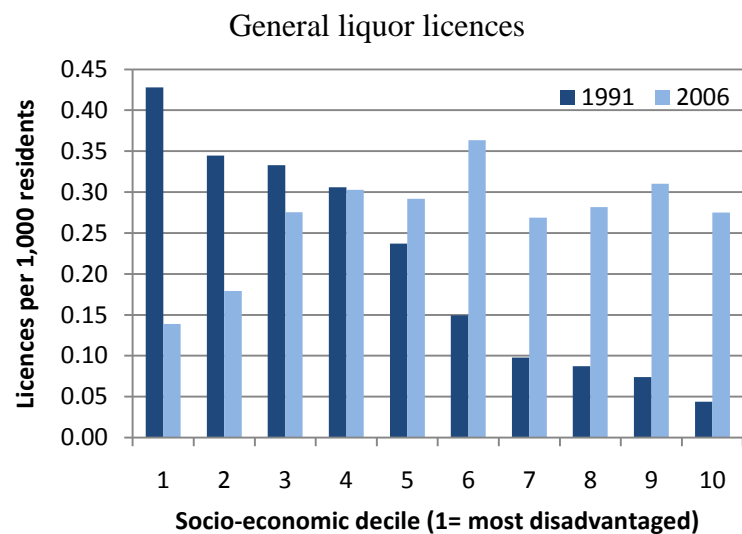


Figure 18 - Alcohol outlets per-capita by decile of socio-economic disadvantage, 1991 and 2006, metropolitan Victoria

A more detailed examination of the data found that this substantial change in the socio-economic distribution of general outlets occurred almost entirely between the 1991 and 1996 Censuses, with the spread of general outlets across SEIFA deciles staying more or less the same between 1996 and 2006. When the specifics of this change were explored visually, it was clear that these results reflected a substantial gentrification of large areas of inner-city Melbourne between 1991 and 1996, rather than a dramatic shift in the location of general outlets within the city. In other words, many suburbs that had been highly disadvantaged in 1991 and had a large number of general outlets had, by 1996, experienced a substantial reduction in socio-economic disadvantage without a corresponding reduction in general outlets. This is presented visually in Figure 19, below. While the distribution of general outlets (the green spots) remained fairly stable over the time period, the socio-economic status of large sections of the inner-city shifted from highly disadvantaged (dark blue) to advantaged (yellow).

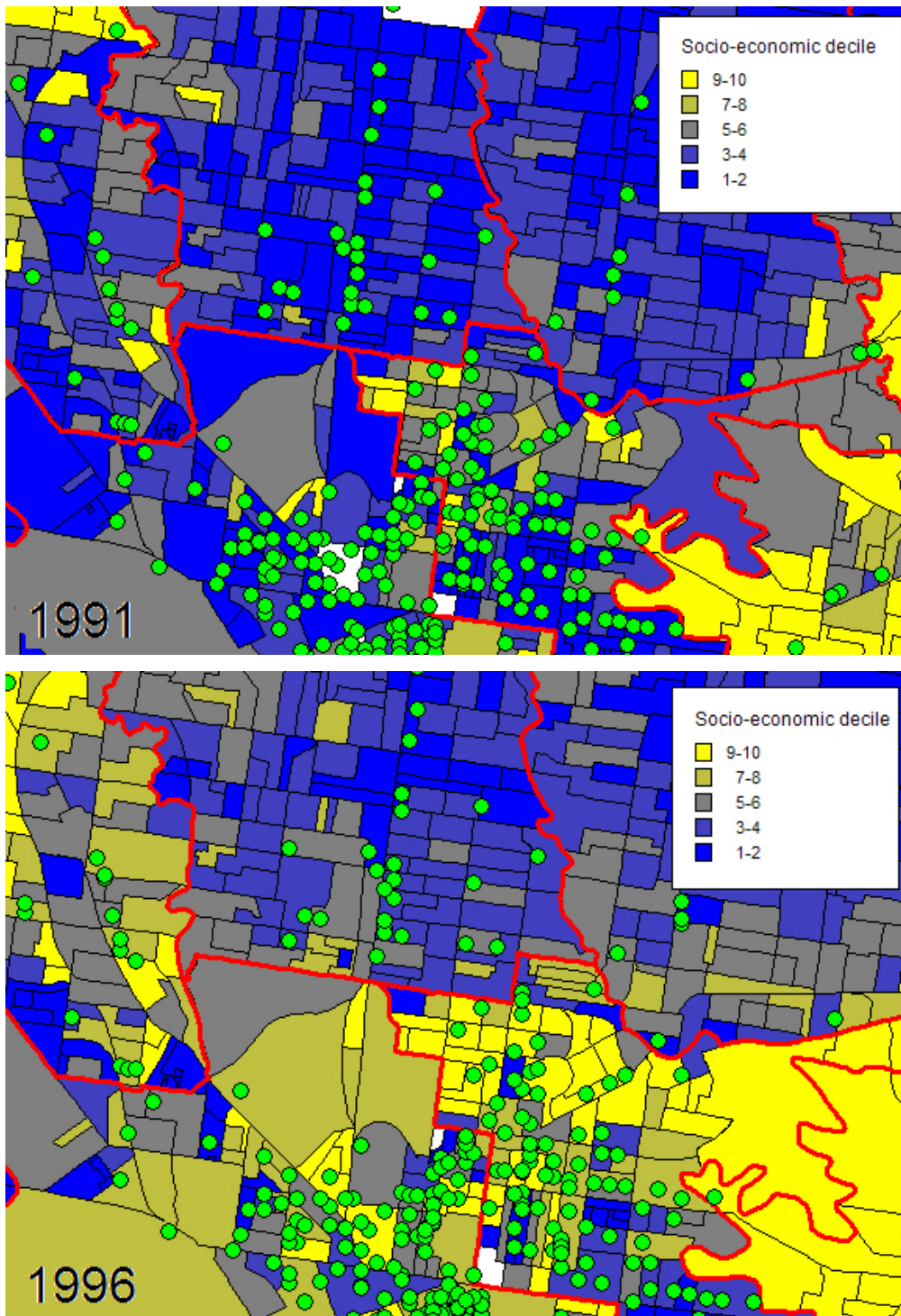


Figure 19 - Distribution of general alcohol outlets by socio-economic decile, inner Melbourne, 1991 and 1996, green circles represent general (hotel/pub) outlets

The data presented above reflect the socio-economic distribution of outlets over time. As noted, this can be altered either by changes to neighbourhoods or to changes in the location of outlets. To explore more specifically how changes at the neighbourhood level altered the distribution of alcohol outlets between 1991 and 2006, a series of fixed-effects models were developed using data from the four Census years. These data were based on consistent geographical units (2006 Statistical Local Areas), with historical Census and licensing data concorded to these fixed boundaries. The areas under analysis in this section (SLAs) are substantially larger than those examined previously (on average, each SLA contains approximately 20 CDs).

The modelling approach used, fixed-effects modelling, maximises the explained variance within units, thus the results of the models reflect how changes in the independent variables across the time period are related to changes in the dependent variables. The models presented below were based on 201 SLAs across four time points (1991, 1996, 2001 and 2006). The models presented below assess how changes in socio-economic status, demography and population relate to changes in alcohol outlet density over time. Dummy variables for year are included to control out broad city-wide trends, but are excluded from the table for clarity. Results for the metropolitan SLAs are presented in Table 32.

Table 32 - Negative binomial fixed effects models of the relationship between alcohol outlet density and socio-economic disadvantage, 1991-2006, metropolitan Victoria

Variable	General		Packaged		On-premise	
	Coef	P-value	Coef	P-value	Coef	P-value
Decile	-0.02	0.38	-0.01	0.71	0.03	0.11
Population (1,000s)	0.02	0.02	0.02	<0.01	0.01	<0.01
% male	-0.01	0.94	-0.02	0.67	-0.01	0.76
% visitors	-0.01	0.70	-0.01	0.93	-0.02	0.51
% aged 15-34	0.01	0.23	0.01	0.67	-0.01	0.03

Longitudinally, there was no association between socio-economic status and outlet density. Only population was associated with outlet density, with general, packaged and on-premise outlet numbers increasing along with the resident population. The other demographic factors included in the analysis were also non-significant.

These results appear at odds with the descriptive analyses presented above, which show substantial shifts in the socio-economic gradient of general licence density. However, as was discussed, this shift has been driven not by a change in the location of general outlets as neighbourhoods get richer or poorer, but by the gentrification of areas that have consistently had large numbers of general outlets across the time period. Thus, these findings are in some sense supported, as the number of outlets in these neighbourhoods was largely unaffected by changes in their socio-economic status over time. It is also worth noting that the longitudinal analysis presented here uses substantially larger geographical units, which may distort the actual associations between outlet density and disadvantage that exist at lower levels.

Clearly there have been substantial shifts in the socio-economic distribution of most licence categories (with the exception of packaged outlets), but these shifts appear to have occurred via the gentrification of neighbourhoods rather than via shifts in the location of licences. This section has thus highlighted that the link between the socio-economic disadvantage of a neighbourhood and alcohol availability over time is minimal and that any impact of the relaxation of licensing laws in Victoria on the inequalities associated with alcohol availability has been small. The biggest change in socio-economic distribution observed (the shift for urban general outlets) had little to do with the changes to the licensing environment, with inner-city gentrification playing the key role. It is worth noting that, despite this gentrification-driven process for general and on-premise outlets, packaged liquor outlets have remained concentrated in the more disadvantaged parts of Melbourne, which suggests that new packaged outlets have disproportionately been opening in disadvantaged areas.

Regional and rural areas

Figure 20 presents the distribution of alcohol outlets by decile of socio-economic disadvantage for 1991 and 2006 in non-metropolitan areas of Victoria. The socio-economic gradients of alcohol outlet density have been largely stable in regional and rural areas. General and packaged liquor outlets were more common in disadvantaged areas in 1991 and this remains the case in 2006. Similarly, the distribution of on-premise licences has changed very little over the time period (even as their number has more than tripled). Increases in packaged and on-premise densities have been particularly pronounced in the lower three deciles, indicating potentially increasing inequalities.

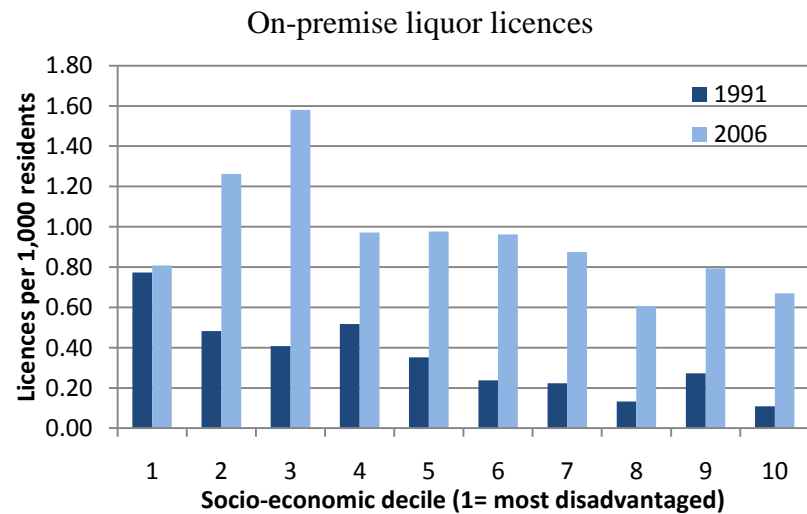
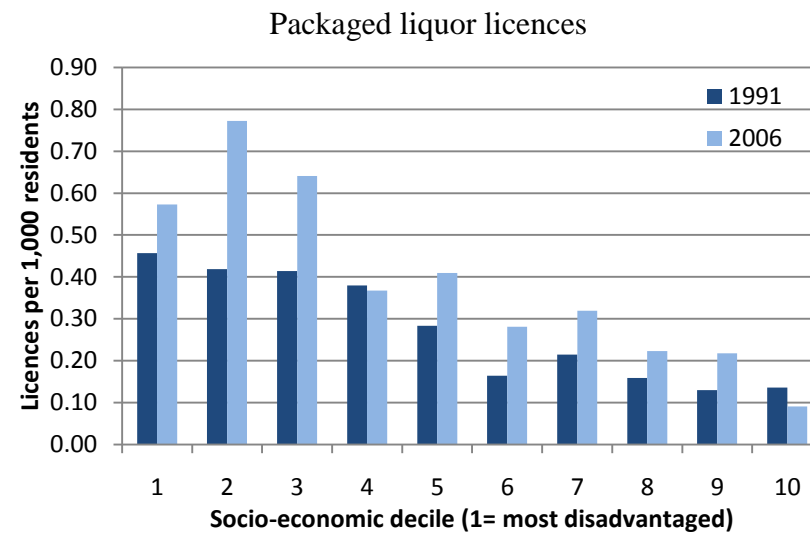
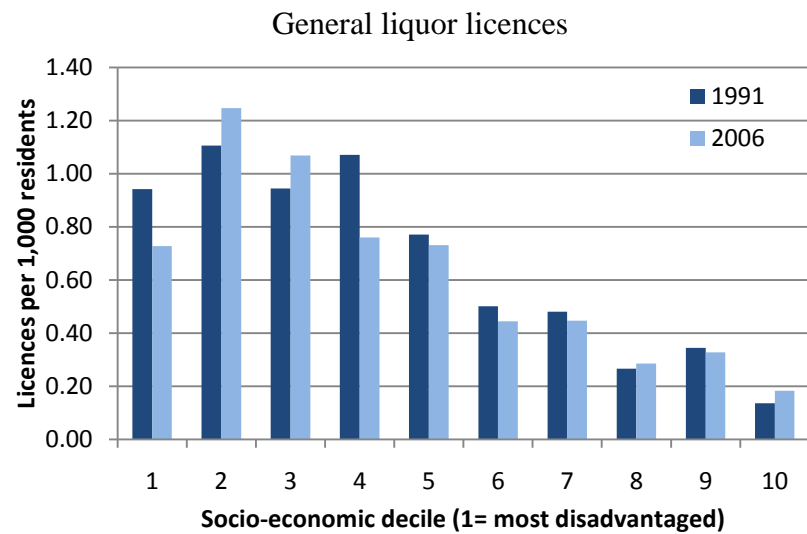


Figure 20- Alcohol outlets per-capita by decile of socio-economic disadvantage, 1991 and 2006, non-metropolitan Victoria

The lack of change in the distribution of alcohol outlets in rural and regional areas is further emphasised by the results of fixed-effects models developed using SLAs as the geographic units (Table 33).

Table 33 - Negative binomial fixed effects models of the relationship between alcohol outlet density and socio-economic disadvantage, 1991-2006, rural and regional Victoria

Variable	General		Pack		On-premise	
	Coef	P-value	Coef	P-value	Coef	P-value
Decile	0.02	0.58	0.05	0.30	0.06	0.12
Population (1,000s)	0.02	0.36	0.03	0.26	0.03	0.08
% male	-0.01	0.76	-0.02	0.74	0.03	0.56
% visitors	-0.06	0.60	0.07	0.57	0.03	0.79
% aged 15-34	-0.01	0.74	-0.02	0.39	-0.02	0.34

Again, there are no significant relationships between licence numbers and changes in socio-economic status over time. Thus, in regional areas, access to alcohol was heavily skewed towards more disadvantaged neighbourhoods in 1991, a situation that did not change substantially in the ensuing 15 years, despite the absolute densities of alcohol outlets increasing markedly.

8.4. Discussion

Cross-sectional findings

The distribution of alcohol outlets observed in the metropolitan 2006 data in some ways makes simple economic sense. Outlets where alcohol is typically more expensive (general and on-premise outlets) are more likely to be located in areas of socio-economic advantage, while outlets where alcohol is sold most cheaply (packaged outlets) are more prevalent in disadvantaged areas. Thus, the results found here are likely to be, at least in part, the result of careful planning by the operators of outlets, targeting their premises to the most appropriate market. It is also possible that the distribution of outlets found in Victoria is simply a reflection of the demand for alcohol at particular price points. However, it is also plausible that the outcomes found here relate to inequalities in community-level power. For example, disadvantaged communities may find it harder to influence planning and zoning decisions and thus be unable to limit the proliferation of packaged outlets in their neighbourhoods. This

lack of community influence is partly supported by the repeated defeat of objections to packaged liquor licences in disadvantaged communities (401, 402).

The higher rates of exposure to packaged alcohol outlets in both urban and rural Victoria is of particular concern with respect to health inequalities in the State. As was discussed earlier, rates of alcohol related harm in Victoria are higher among people who are more socio-economically disadvantaged (264). This is particularly the case for rates of chronic harm, such as liver cirrhosis (383). The evidence presented in the previous chapters of this thesis suggests there is a robust relationship between the density of packaged liquor outlets in a community and the experience of alcohol-related harm in that community, including for chronic outcomes. Thus, the findings of this study provide an indication that some of the socio-economic disparities in alcohol-related harm found in Victoria may be related to an inequitable distribution of packaged alcohol outlets by level of disadvantage. In contrast, the positive association between economic advantage and the density of general outlets may act to reduce socio-economic disparities in rates of alcohol-related harm, as densities of these outlets have also been linked to alcohol-related harm (particularly violence). However, general outlets are more likely to serve patrons from outside their direct neighbourhood, meaning that these effects may be less likely to be experienced only by people living in the more advantaged neighbourhoods with high densities of general outlets. This is supported in part by the large proportion of alcohol-related assault victims in Melbourne's (socio-economically advantaged) CBD who reside in disadvantaged outer suburbs of the city (403).

Longitudinal findings

The longitudinal data presented here show that there have been only minor associations between changes in the socio-economic status of a neighbourhood and changes in alcohol availability in Victoria in the past two decades. Certainly, the findings of this study suggest that the liberalisation of licensing laws and subsequent expansion of the alcohol market in Victoria have not resulted in increased socio-economic disparities in exposure to alcohol outlets. For all categories examined except for general and on-premise licences in urban areas, disadvantaged neighbourhoods had substantially higher densities of alcohol outlets in 1991 and in 2006, with the magnitude of the disparities staying fairly constant, even as total rates increased. Urban on-premise outlets went from being concentrated largely in disadvantaged neighbourhoods in 1991 to be spread relatively evenly across the city. Contrastingly, between 1991 and 2006 there was a redistribution of general outlets in urban

areas such that the socio-economic gradient completely reversed. This change has come about largely through the gentrification of neighbourhoods with historically high numbers of general outlets rather than via significant changes in the actual location of general outlets in Melbourne.

While the causes of gentrification in inner-Melbourne are complex and varied (404-406), it is worth noting that the transition of these neighbourhoods from areas of socio-economic disadvantage to more wealthy areas occurred without any shift in the numbers of pubs within them. Historically, these were working class and immigrant areas, with large numbers of pubs (e.g. 407). It may have been expected that gentrification of these areas would have led to a reduction in the number of pubs, as middle-class residents exerted their influence on the local environment. However, this has clearly not taken place, with the existing pubs instead finding new markets. This is likely to be at least partly caused by the substantial inertia in the licensing system, with operating licences granted existing-use rights even when they're use falls outside of local planning and zoning policies (408). Further, it is possible that the wide array of drinking options available in the inner-city areas contributed to their gentrification. While the regeneration of urban areas is often used as a rationale for liberalising licensing laws, there are mixed views as to their effects. For example, research in the United Kingdom suggests that, contrary to government arguments, the liberalisation of the Licensing Act there is unlikely to revitalise city centres and towns (409). However, there is evidence from Auckland and New York that diverse drinking places contributed to the 'trendification' of previously working class inner-city suburbs (410, 411). Clearly gentrification in inner-city Melbourne involved a fracturing of the middle-class, with bohemians and students attracting 'trendy' affluence, while young families continued to settle in the suburbs (404). This gentrification would also have had a significant impact on real estate prices in inner-city neighbourhoods, which may also have contributed to existing pubs staying operational, as their investment accrued value.

It is also worth considering how accessible general licences have been in Melbourne since the liberalisation of liquor licensing in the late 1980s. In many ways, the revisions of the acts in the 1987 and 1998 were focussed on reducing the dominance of the hotel in the alcohol market, by opening the way for new venues providing alcohol for on-premise consumption (such as restaurants and bars) and opening up the packaged liquor market. Thus, the various

changes to the act have had larger impacts on licence categories other than general licences. While the precise mechanisms restricting the growth of general licence numbers remains unclear, historical work demonstrates that prospective licensees searched for already licensed venues (with existing use rights) rather than apply for new general licences (13), suggesting that, perhaps at a more informal level, significant controls remained. Indeed, the ‘existing use’ rights enshrined in Victorian liquor licensing mean that general licences are rarely extinguished, ensuring limited spatial mobility in the industry. This reinforces the current findings – that general licence numbers did not shift in concert with changes in socio-demographics, partly reflecting the ease of maintaining existing licences as opposed to applying for new ones.

While beyond the scope of the current study, the shifts in the socio-economic gradient of pub density raises interesting questions related to this link in Melbourne. It is particularly noteworthy that the significant liberalisation of Victorian liquor licensing laws in 1988 coincided with an acceleration in the gentrifying of inner-city areas in Melbourne. It’s not clear whether this phenomenon is unique to Melbourne, or whether other large cities have experienced a shift in the socio-economic profile of drinking places. Future research internationally should explore the links between licensing laws and urban regeneration over periods of gentrification.

The discussion thus far has focussed on the anomalous finding. It is worth noting that even in the midst of the gentrification discussed above, packaged liquor outlets have maintained a substantial negative social gradient. People in disadvantaged areas were exposed to around twice the rate of packaged liquor outlets in 1991, and this disparity remains at roughly the same magnitude in 2006. Similarly, in regional areas, both general and packaged outlets remained substantially more prevalent in disadvantaged areas following deregulation, suggesting that substantial socio-economic disparities in exposure to alcohol outlets have remained. These findings suggest that, unlike pubs, the locations of these kinds of outlets shifted over the last two decades. This may reflect the smaller costs of opening new retail outlets (compared to pubs), which increases the flexibility of the packaged liquor market. Further, packaged outlets have historically been subject to fewer planning and licensing restrictions, meaning that the ‘existing use’ rights that kept pubs in the same locations had little or no impact on the packaged market. Thus, in combination with the work presented

earlier in this thesis, this suggests that the liberalisation of the licensing in Victoria contributed to substantial increases in alcohol-related harm in ways that were likely to maintain the substantial socio-economic disparities in the experience of these harms.

Limitations

The current work is limited by the available data. Firstly, the findings are based on aggregated data, which likely masks significant individual level variation. Similarly, the study doesn't account for the actual use of alcohol outlets. It is likely that outlets of all types are visited by large numbers of customers from outside the CD they are located in. Thus, a bottle shop in a poor area may serve many customers from nearby wealthier areas. This effect will be even more pronounced for general, club and on-premise outlets, which may serve as destinations in themselves, drawing custom from areas some distance away. Despite these issues, it is worth noting again that respondents living in areas with higher densities of outlets have been demonstrated to experience higher rates of harm, so the distribution of outlets remains important, even while their use may span a larger catchment than analysed here. In addition, analysis at the smallest geographical level (CD) is only possible at a descriptive level, with no demographic controls due to changes in CD boundaries between Censuses. Thus, the results of the analysis relying on these units are not entirely consistent with the more rigorous models developed using larger (and more heterogeneous) Statistical Local Areas. Even in these SLA-based models, only a limited number of control measures were available for use in this study. The density of alcohol outlets is likely to be driven by a range of factors not considered here, including, for example, the distribution of other commercial outlets. Finally, the analysis relies on relatively crude measures of alcohol outlets, not differentiating between pubs or bottleshops with different characteristics (e.g. size, character, primary function etc). Thus, for example, it is likely that the general outlets in the gentrified inner-city areas of Melbourne have changed character substantially over the study period, but this change cannot be incorporated into the current analytical approach.

Conclusions

In spite of the limitations discussed above, the findings of this study are broadly consistent with a wider literature on health inequalities and alcohol availability (e.g. 195), with Victorians living in more disadvantaged communities exposed to substantially higher rates of alcohol outlets (particularly packaged liquor). This is the first study to examine changes in these inequalities over time, and the findings of the longitudinal analyses suggest that the

liberalisation of the alcohol market does not make these inequalities worse, although reductions in inequalities of exposure were only noted for particular types of urban outlets. Thus, future alcohol policies that are aimed at reducing health inequalities in Victoria should focus in particular on reducing the disproportionate number of packaged liquor outlet numbers located in disadvantaged neighbourhoods.

Chapter 9. Conclusions

9.1. Summary of results

This thesis has attempted to assess the effects of substantial shifts in liquor licensing policies in Victoria over a period of two decades. This was done by first examining broad state-level trends in alcohol consumption and related problems and then by undertaking a series of detailed quantitative analyses utilising the variation in licensing changes at a local level to explore the influence of changes in outlet numbers on problem rates. Finally, there was an examination of the potential role of liquor licensing policy and the distribution of alcohol outlets in contributing to socio-economic inequalities in negative health and social outcomes related to alcohol.

Broad trends

The data presented in the first chapter highlight the magnitude of the licensing changes being examined in this thesis, with the number of alcohol outlets growing dramatically throughout the 1990s and 2000s, following a period of relative stasis. These changes, driven by two major revisions to the legislation governing liquor licensing, have seen the number of pubs increase by 40%, a doubling in the number of bottle-shops, and a nine-fold increase in restaurants and bars over a twenty year period.

This increase in availability has coincided with sharp increases in rates of alcohol-related harm, as measured across a number of distinct indicators, including police, hospital, emergency and treatment data. Despite the consistency across most indicators, the most reliable indicator of alcohol-related harm (mortality) showed no overall trend across the study period. However, subsequent analyses highlighted significant increases in alcohol-specific acute harms (Figure 8), suggesting that the lack of an overall mortality trend may relate to lags between behavioural changes and chronic disease mortality. The general increases in alcohol-related harm were not isolated to particular sub-groups of the population (such as youth), and imply a substantially worsening public health problem in Victoria. In contrast, the data available on alcohol consumption in the state presents a broadly stable picture, with most survey-based measures of risky drinking stable or even declining. The only sign of increases in problematic consumption detected in the analyses presented here came from a measure of very heavy drinking (20+ drinks per occasion) by young adults (16-24), which has nearly

doubled in the last ten years. This divergence between trends in general measures of consumption and trends in alcohol-related harm was unexpected. It raises some significant questions for the broad public-health approach to alcohol policy, which generally focuses on reducing consumption rates based on the (widely validated) assumption that harm rates are highly correlated with consumption levels (42). Regardless, the sharp increases in the broad trends in alcohol-related harm are in concordance with the massive expansion of the market, consistent with the hypothesis that the increase in outlet numbers has resulted in higher rates of alcohol problems. This broad contention was tested by undertaking a series of studies focussing on the associations between outlet numbers and problem rates at the community level. The findings of these studies are briefly revisited below.

Small area studies of outlet density and harm

The specific, local relationships between alcohol availability (in terms of outlet numbers) and alcohol-related problems were tackled across four chapters of this thesis, focussing on: very heavy drinking amongst young adults, general assaults, domestic violence and chronic disease.

Chapter 4 presented a cross-sectional multi-level study of very heavy drinking amongst young adults, finding a range of individual level factors related to heavy drinking. Importantly, the study also identified that a key community-level factor predicting the prevalence of very heavy drinking was the density of packaged liquor outlets in a young person's community.

Analyses focussing on the link between alcohol outlets and rates of general violence were presented in Chapter 5 and Chapter 7. The overall picture suggested by these analyses is a strong link between the density of general licence outlets and violence rates, with particularly problematic effects in areas of high existing availability. There was also reasonable evidence that packaged liquor outlet density was related to assaults, with significant effects found in both longitudinal analyses. Finally, there was some suggestion of a small effect for on-premise outlets, particularly in suburban areas.

A longitudinal examination of the relationship between alcohol outlet density and domestic violence was presented in Chapter 6. This study found a strong relationship between packaged liquor outlets and domestic violence. Interestingly, while general outlets were not

significantly related to domestic violence overall, there were significant effects in particular clusters of postcodes, suggesting different patterns of alcohol use and partner violence in different neighbourhood types.

The final analysis of the effects of local-level changes in alcohol outlet density focussed on its relationship with chronic disease (Chapter 7), finding a strong relationship between packaged liquor outlets and alcohol-caused chronic hospital admissions and a weak effect for on-premise outlets.

In summary, the small-area studies presented in this thesis all found significant positive relationships between outlet density and alcohol problems. The specific relationships are broadly summarised below in Table 34.

Table 34 - Summary of findings from Chapters 4-7: strength of relation of particular problems with numbers of licences, by licence type

	General	Packaged	On-premise
Youth heavy drinking		↑	
General assault	↑	↑	↑
Domestic violence	↑	↑	
Chronic disease		↑	↑

Clearly the density of packaged liquor outlets is a key concern for public health, with consistent moderate or strong positive effects on all the harms studied here. In addition, the density of general licence outlets (pubs) is a key driver of general violence, consistently identified across three different analytical approaches to this question.

Socio-economic inequalities and alcohol availability

The final empirical section of this thesis documented significant socio-economic disparities in exposure to alcohol outlets. In rural and regional areas of Victoria, people living in disadvantaged neighbourhoods were exposed to significantly higher densities of all kinds of

alcohol outlets, while in urban areas packaged liquor outlets clustered in poor areas. Given the findings discussed above, this has clear implications for inequalities in health outcomes, with people living in disadvantaged neighbourhoods likely to be at higher risk of a range of alcohol-related harms due to their disproportionate exposure to high levels of outlet density.

This study also attempted to assess how the liberalisation of licensing law in Victoria had impacted on inequalities. In general terms it had not – the majority of the inequalities present in 1991 remained in 2006, despite a massive expansion of the alcohol industry. There was some lessening of inequalities in exposure in relation to urban general licences, with the gentrification of the pub-rich inner-city leading to higher outlet densities in areas of socio-economic advantage.

Summary

Taken together, the research presented here demonstrates that alcohol-related harm has increased dramatically over a period of substantial industry expansion. Further, the small-area findings provide increasingly powerful evidence that these trends are related, with rates of harm from alcohol at the local level increasing in concert with local level outlet densities. In particular, this work suggests that packaged liquor outlets (which are shown to be disproportionately clustered in poor neighbourhoods) are key drivers of alcohol-related harm in Victoria.

9.2. Limitations

The specific limitations on the individual studies that make up this thesis have been discussed in each chapter and will not be re-examined in detail here. There are some over-arching limitations of the entire thesis that are discussed here.

Firstly, these studies (like all studies examining neighbourhood level determinants of health) are potentially confounded by selection effects. The neighbourhoods that people choose to live in are not random, and there is the potential that factors found to be associated with harm rates at the neighbourhood-level are entirely confounded with characteristics of the neighbourhood population. These issues are best summarised in a series of articles and commentaries sparked by Oakes' concerns about the validity of all neighbourhood-level observational epidemiology (60, 412-417) (although are widely discussed, (418-420). Thus,

for example, the association between risky drinking and packaged liquor outlet density identified in Chapter 4 may merely reflect the preferences for heavy drinking young people to live in neighbourhoods with ready availability of alcohol (or vice-versa, it may reflect the propensity of the alcohol industry to accurately target its retail outlets). In multi-level studies (such as that presented in Chapter 4), the incorporation of a wide-range of individual-level and community-level control variables is used to minimise this risk, although it remains an issue of concern. This is similarly a significant limitation of the cross-sectional analysis of alcohol-related violence presented in Chapter 5. The relationships found (higher rates of violence in suburbs with higher densities of alcohol outlets) may reflect differences in the underlying populations making use of these neighbourhoods. Again, a range of other neighbourhood characteristics were controlled in these analyses, but there is a reasonable possibility that unmeasured factors correlated with both outlet density and violence rates explain some of the relationships observed.

There is no way to completely resolve this issue in cross-sectional studies, and this is why the majority of the studies in this thesis have examined change over time using longitudinal data. As Diez-Roux notes, longitudinal studies that examine change over time provide a more robust way to examine neighbourhood effects (412, p1954). For selection effects to bias the results of the longitudinal studies presented here, populations of heavy-drinking/violence-prone individuals would need to be moving into neighbourhoods as outlet densities change. The longitudinal results presented in Chapter 8 raise some issues in this regard – the characteristics of the suburbs with high densities of hotels (general licences) have changed substantially over the last two decades, as the inner-city has gentrified around them. These findings provide some suggestion that alcohol outlets may act as specific attractors to sub-populations and that the longitudinal associations between outlet density and alcohol problems identified in previous chapters reflect these selection effects rather than a direct affect of outlet densities on problems. This is obviously plausible, but would require substantial population mobility. Based on data from the 2006 Australian Census, around 80% of Melbourne residents remain at the same address from year to year (Unpublished data, Australian Bureau of Statistics), which suggests that longitudinal selection effects are unlikely to significantly bias the findings presented here.

The remaining key limitations of the work presented here stem from limits of the data available for analysis. In terms of the outcomes focussed on, the use of administrative data sources such as police and hospital data introduces a range of potential biases into the analysis (201, 421). Thus, for example, the use of police data to measure the assault rate in the work presented in Chapter 5 raises some concerns. Police-based measures of crimes such as assault are likely to be heavily biased by the operational priorities of the police and of the willingness of victims of crime to report incidents to them (201). Indeed, the findings presented in Chapter 5 could be driven substantially by operational policing decisions if, for example, police resources were explicitly directed in response to changes in the alcohol market. In other words, if the Victorian police committed more police to areas where the number of pubs increased and subsequently detected more assaults in those areas (based not on increased crime rates but on increased detection), then the relationship found between general outlets and assault rates would be spurious. This is an extreme example and is unlikely to be responsible for the entire relationship observed, but it highlights the caution required in interpreting findings based on police data. Some reassurance in this particular case is given by the analogous findings derived from similar analyses based on hospitalisations related to assault presented in Chapter 7. There is further concern about the use of police records of domestic violence as an objective outcome measure of partner violence given the chronic under-reporting of this form of violence to police (422). If under-reporting rates are correlated in some way with the local alcohol environment, then biases in the findings of Chapter 6 are likely. The use of a broad measure of socio-economic disadvantage as a control variable mitigates against this, but cannot completely remove uncertainties about the findings.

The use of hospital admission data in Chapter 7 is less immediately problematic than the use of police data. However, there remain significant limitations associated with the use of this form of data. Trends and patterns observed from the data may not always accurately reflect trends and patterns in the underlying morbidity rates. In particular, rates of presentation to hospital can vary substantially across time and space, as can the coding and diagnostic practices of hospital staff (216). Thus, for example, if hospitals in areas with increasing numbers of alcohol outlets were increasingly likely to use diagnostic codes related to alcohol consumption, it would create a correlation between outlet density and alcohol-related hospital admission rates that reflects operational factors rather than the underlying relationships. The

magnitude of any such potential bias is likely to be relatively small, and the concordant findings between the hospital- and police-based analyses of violence increase the likelihood that these findings are not overly affected by biases in the outcome measures used.

Further, the use of proxy-measures of alcohol-related problems in a number of the studies means that their findings should be interpreted cautiously. For example, the studies in Chapter 5 used police assault data based on time of day and day of week (i.e. late-night weekend assaults) as a proxy measure for alcohol-related violence. This proxy is based on some previous local analyses (223) and is consistent with the approach to measuring alcohol-related violence suggested by the WHO (217). It is still worth noting that it is not a comprehensive way of measuring alcohol-related assaults and will both capture some non alcohol-related events and miss some assaults that are linked to alcohol. However, given the challenges of measuring alcohol involvement in violence (and the inherent difficulties in getting police to reliably record it), this measure was the most robust available. A similar issue occurs in the study of hospital admissions for assault (Chapter 7). In this chapter, the analysis includes all assault admissions, with no attempt made to select alcohol-related events. This is largely due to data limitations – Victorian hospitals do not reliably code alcohol involvement on admissions, and even in jurisdictions where these codes are used they have noted weaknesses (423). The use of an overall assault measure increases the possibility that non-alcohol factors may introduce some bias to the study - in the worst case scenario, non-alcohol-related assaults may increase in areas of high outlet density for unmeasured reasons, leading to an entirely spurious correlation. However, this is relatively implausible and is unlikely to have had a major impact on the findings presented in Chapter 7.

In addition, the licensing data used to measure exposure to alcohol outlets across this thesis was inherently limited. Firstly, the licence categories create some challenges for interpretation. In particular, the ‘on-premise’ licence category incorporates some bars and nightclubs as well as restaurants, making the interpretation of effects of on-premise density challenging. Similarly, the fact that outlets with general licences sell alcohol for both on- and off-premise consumption means that only cautious interpretation of the general licence density effects are reasonable. Further, the measures used throughout were based on simple counts of outlets of various types and included no further detailed information on the nature or operation of particular outlets. Thus, any two premises with the same broad licence type

are treated as equivalent in all the analyses undertaken here. This is problematic given the wide range of business types covered by these designations. For example general licences include premises with licensed capacities in excess of 5,000 patrons as well as corner pubs with capacities of less than 100. Similarly, a warehouse size liquor store and a small grocery store with a liquor section are both treated as single packaged outlets in these analyses despite their many differences. In addition, despite the widespread evidence that trading hours are critical factors affecting the contribution of licensed outlets to alcohol-related problems (e.g. 47), the data used here could not disaggregate premises into late- and early-trading outlets. These data shortcomings limit the practical utility of the findings of this thesis, with licensing policies and decisions needing to incorporate a range of factors beyond simple outlet density (424). While this is a substantial problem, this research does at least provide much-needed evidence that a liberalised approach to licensing is likely to bring with it increases in alcohol-related harm. Further research with better data is required to develop more sophisticated policy responses. The collection of local-level sales data in other jurisdictions has provided an example of the benefits of improved data for research in this field, but there remain a range of issues that need to be addressed. Simple, standardised data on licences incorporating such dimensions as outlet capacities, trading hours and volume of alcohol sold would greatly enhance future research into the relationship between liquor licensing policies and alcohol-related problems.

9.3. Implications for research and original contribution

Fitting the results within the existing literature

The studies tackled in this thesis provide results broadly in line with the existing literature, which has been covered in detail both in Chapter 1 and across the empirical chapters. Thus, this section will be just a brief summary of how the key findings broadly relate to the literature. A more detailed discussion of the relationship between some of the findings of this thesis and previous research will be incorporated into the following section which summarises the original contributions made by this work. Where appropriate, the implications suggested by the findings of this thesis for future research will be mentioned.

The empirical studies presented in this thesis fit within the growing literature emphasising the local level relationships between alcohol outlet densities and alcohol-related problems (48, 49). This set of studies represents the first comprehensive Australian attempt to assess the

impact of changes in alcohol outlet numbers (notwithstanding scattered earlier Australian studies in the field – see (121, 199, 361)). Internationally, the studies presented here add to the substantial literatures linking outlet densities to general violence (e.g. 80, 106, 117, 122) and youth drinking (e.g. 95, 102, 103, 170, 253) and broaden the focus of the existing literature by examining less well-studied outcomes (domestic violence and chronic disease). A particular value of the work presented here is the focus on longitudinal relationships, which provide stronger evidence for policy-makers and have been relatively rarely tackled (with some important exceptions (91, 122, 157, 159, 400, 425)). In addition, the work on the socio-economic distribution of alcohol outlets confirms a growing international literature highlighting the concentration of off-premise alcohol outlets in disadvantaged neighbourhoods (e.g. 102, 194-196).

Original contributions and future research directions

As well as supporting and extending the findings of the predominantly U.S.-based literature with a comprehensive set of Australian studies, this thesis has made a number of more specific original contributions to the field.

The summary of Victorian trends in alcohol consumption and alcohol problems in Chapter 3 is the first comprehensive examination of these trends in the state over a period of significant expansion in the alcohol market. The divergence between the trends identified in the harms data and the survey-based measures of consumption are a novel finding, rarely identified previously in the alcohol literature (238). The correspondence between changes in population-level consumption and rates of alcohol-related harm is a key underpinning of the public health approach to alcohol policy and there is an urgent need for further research to understand the disparities observed in Victoria and to determine their implications for future alcohol policy here and elsewhere. This could involve a substantial research program. First and foremost, a broader epidemiological project is required to determine whether the divergence between trends in harm and trends in consumption found in Victorian data is matched in other jurisdictions. There is some evidence of similar patterns in other countries (e.g. 426), but there has yet to be a systematic examination of the topic. The trends found in Victoria could also benefit from further examination. For example, research into the reliability and robustness of the various indicators of alcohol-related harm that are commonly used is required to determine the influence of administrative or other factors in producing the trends identified here. More substantively, the increasing trend in very heavy drinking

amongst young adults identified in the VYADS data requires further investigation to determine whether the changes in very heavy drinking amongst sub-populations such as those seen in this sample have the potential to produce the dramatic harm increases observed.

The study of heavy drinking by young adults presented in Chapter 4 is the first Australian study to explore the relationship between local-level alcohol availability and alcohol consumption. It also makes use of a novel outcome – drinking at levels far in excess of those defined as risky in traditional drinking guidelines (427) and more in line with young people’s perceptions of binge drinking. This line of work requires extension in a number of ways. Firstly, longitudinal analyses of the relationship between alcohol availability and youth drinking are required in an Australian context to provide stronger evidence that alcohol outlet density is causally related to heavy drinking practices. Secondly, more nuanced understandings of how outlet numbers influence drinking behaviour (e.g. via promotions, price competition, convenience) could be developed through mixed-methods studies of youth drinking.

The two studies of alcohol outlet density and assault presented in Chapter 5 have extended the existing literature in a number of ways. Firstly, the cross-sectional study is the first to explicitly test the kinds of relationships between density and violence rates implied by the underlying theories put forward by previous researchers. By developing models incorporating non-linear effects, this study demonstrated that changes in the number of outlets most likely affect violence rates via social mechanisms beyond their simple impacts on consumption rates (e.g. via social disorganisation or impacts on routine activities). The subsequent longitudinal study is only the second study of how gradual changes in outlet numbers relate to violence. In addition, the exploration of the effects of outlet densities on violence across distinct types of neighbourhoods extends the limited previous examination of the contextual effects on the density-violence relationship. Where this issue has been addressed at all, it has generally been limited to broad interactions with socio-economic disadvantage, focussing on whether outlets are more or less problematic in poor neighbourhoods. The study included here used a more sophisticated approach, empirically deriving five distinct clusters of postcodes and exploring how the associations between outlets and violence varied across them. The substantial variations identified suggest distinctly different uses of different types of outlets across Melbourne which are poorly understood. Future research into the ways in

which different sub-populations use alcohol outlets is thus critical to inform licensing policy and broader prevention efforts. In addition, research that provides more nuanced understandings of the kinds of outlets that are likely to be problematic is essential. For example, research examining how the size, characteristics and specific locations of outlets relate to the occurrence of violence in their surrounds would be of great use to policy makers in Victoria and elsewhere.

Chapter 6 includes just the second longitudinal study of the association between outlet density and domestic violence and the first attempt to address this relationship using Australian data. In addition, using a similar approach to the previous chapter, it provides the first analysis to highlight the substantial variations in outlet effects across different neighbourhood types. The relationship between alcohol availability and domestic violence has been the subject of very little research, in part due to the challenges of conducting research in the area. Indeed, ongoing research into how alcohol contributes to incidents of domestic violence is required. Qualitative research examining specific instances of violence may provide some insight into the ways in which the market for alcohol contributes to violence in the home. Further quantitative studies examining the inter-relationships between the price of alcohol, outlet trading hours, outlet numbers and domestic violence may suggest policy approaches to reducing alcohol-related partner violence.

The combination of acute and chronic outcomes in the same analytical frame in Chapter 7 represents an innovative attempt to draw out the mechanisms linking different outlet types to different alcohol-related problems. Building on the routine activities framework developed by Freisthler et al. (74), the study's findings point to distinctly different outlet effects, with off-premise outlets the strongest driver of rates of chronic disease while general outlets (pubs) had the strongest association with violence rates. These findings suggest that packaged liquor outlets have particular effects on the consumption of vulnerable problematic drinkers susceptible to chronic alcohol-caused morbidity, while general outlets act to bring together potential offenders and victims and thus increase violence rates. This work, along with the contextual analytical approaches from the previous two chapters discussed above, highlights the complex ways in which different outlets affect different behaviours in different types of neighbourhoods. This has substantial implications for the development of appropriate policies and emphasises the need for research approaches that extend beyond simplistic outlet-

violence associations. Further, the effects of outlets on chronic conditions suggest that alcohol availability has greater impact on marginalised or heavy drinkers, a possibility that requires further investigation.

Finally, the analyses of the socio-economic distribution of alcohol outlets in Victoria presented in Chapter 8 are the first Australian attempt to tackle how alcohol-related health inequalities may be affected by the ways in which outlets are located across communities. Further, the longitudinal analysis in this chapter that examined how the liberalisation of the licensing regime in Victoria affected socio-economic disparities in alcohol outlet densities was the first of its kind in the international research literature. The relationship between pubs and gentrification in inner-city Melbourne pointed to by this study suggests a potentially fruitful area of research for social geographers interested in the gentrification process in Australia.

9.4. Policy implications

This thesis clearly identifies a range of negative outcomes associated with the increasing density of liquor licences in Melbourne, with packaged liquor outlets in particular associated with a wide array of harms. Given the recent history of liquor licensing policy in Victoria, these findings are important in and of themselves. Both the Nieuwenhuysen review and the subsequent 1998 revision of the Liquor Control Act assessed the available research evidence and concluded that increasing the number of places selling alcohol in Victoria would have no negative health or social impacts. Thus, both reviews made their recommendations based largely on issues of competition and market efficiency rather than on public health grounds. The findings of this work refute the assumptions behind these decisions and will be critical in informing future liquor licensing policy decisions aimed at limiting the harms from alcohol.

The findings are important on a day to day level for planning and licensing decisions, providing critical evidence for local planners and social impact assessors to incorporate into their decision-making. The evidence presented here is already widely cited in licensing hearings as local governments attempt to develop more public health-oriented approaches to licensing (e.g. 402). However, these attempts have been hamstrung by the focus of the legislation on which decisions of the judicial body charged with resolving contested licensing hearings have to be based – requiring premise-specific evidence of harm. In other words, a

council needs to provide specific evidence of why a particular new outlet will cause harm and cannot rely on the probabilistic evidence made possible by work like that presented in this thesis. This has meant that local councils have been unable to reject new licensed premises even in situations where studies like those presented here would suggest they would increase community harms substantially. Indeed, the findings demonstrating the differing outlet effects in different neighbourhood types provide a means for decision-makers to make probabilistic decisions on where new licences are likely to cause the most harm. Ideally, future licensing legislation will empower local governments to have more control over their local licensing environment, whether through the incorporation of probabilistic arguments in hearings or through specific policy mechanisms that return some control to the local level (335). The recent regulatory shifts to include some consideration of the cumulative impact of licensed premises in planning decisions and to require planning approval for retail alcohol outlets represent small steps in this direction (428), although their practical implications remain unclear.

A particular concern raised by the findings that packaged liquor density is a key contributor to rates of domestic violence and chronic disease is the ongoing expansion of the retail market driven by the two major Australian grocery chains (429). This expansion has been facilitated by deregulation specifically aimed at reducing restrictions on these chains and has led to a sharp increase in the number of new outlets opening and a struggle for market domination that has meant routine discounting of alcohol below wholesale price (24). While the previous Victorian policy approach of capping the proportion of the market that any one company could own at 8% was considered anti-competitive by the National Competition Council, it did at least limit the growth of the market which has been unleashed since it was removed. Whether policy-makers return to a similar capping scheme or go for a more wide-ranging approach to limiting outlet growth (e.g. the Californian method of limiting the number of stores on a per-capita basis (38)), some policy intervention is needed to curb the rapid increase in retail outlets currently taking place in Victoria.

In recent years, the Victorian government has attempted a range of policy interventions to reduce alcohol-related problems, particularly focussing on late-night violence. Since 2008 a cap has been in place on new licences in the inner-city areas that trade beyond 1am (430). This has limited the growth of late-trading outlets, although there has been no reduction, as

licensees can transfer existing licences between venues and owners. In mid-2008 a 2am lock-out was instituted on a trial basis but was dropped following legal wrangling that exempted most late trading outlets from it (431). More recently, the outgoing Labor government restructured their licensing fee regime, making outlets with risk factors related to violence (large capacities, late trading, previous breaches) pay higher fees (424). This approach ignores the significant harms due to alcohol that occur outside the night-time economy. In any case the new fee structure has been subsequently undermined by the new Coalition government, who cut the fees in half following controversy surrounding the closure of an iconic inner-city pub (432). Both of these regulatory attempts to reduce alcohol-related problems have represented relatively minor intrusions on the market, but both were met by substantial industry and community protest (433, 434). This highlights the key policy challenge for governments aiming to reduce alcohol-related harm through regulation: the politics. The kinds of solutions suggested by this thesis (i.e. policies aimed at a reduction in the number of alcohol outlets) are likely to meet fierce industry-driven resistance and will require a particularly bold government or a groundswell of public support. Regardless, the evidence presented here suggests that the continued unchecked growth of the alcohol market in Victoria will come with significant public health costs, pointing to the need for the hard policy decisions that are required in this area.

9.5. Conclusions

This thesis has examined the association between alcohol outlet density and alcohol-related harm in Victoria during a period of rapid deregulation. The sharply increasing trends in alcohol-related problems coupled with the small-area studies highlighting significant local covariation in outlet numbers and harms suggest that the process of liquor deregulation in Victoria has led to a range of health and social problems. These findings fit with the broad alcohol policy literature highlighting the role of restrictions on physical availability in reducing alcohol-related harm, and have significant implications for liquor licensing policy in Victoria, in the rest of Australia and internationally.

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