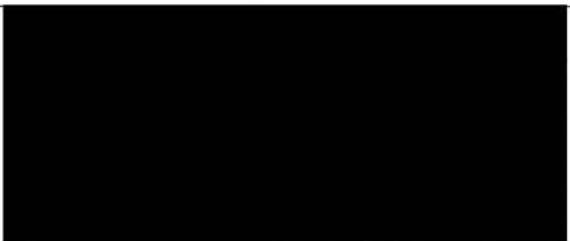**IN THE MATTER OF THE ROYAL COMMISSION
INTO FAMILY VIOLENCE**

ATTACHMENT CC-9 TO STATEMENT OF CATHERINE MARY CARR

Date of document: 13 July 2015
Filed on behalf of: State of Victoria
Prepared by:
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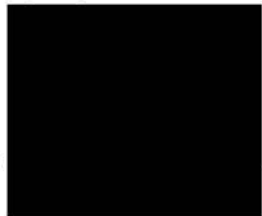
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Alcohol outlet density and harm: Comparing the impacts on violence and chronic harms

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Abstract

Introduction and Aims. *A number of studies have previously identified relationships between the density of alcohol outlets and rates of violence, with different types of outlets related to violence in different locations. The previous work in Australia has been limited to studies based on police data, which are subject to numerous biases. This study extends the previous work by utilising hospital admissions as a less biased outcome measure, incorporating a 14 year longitudinal design and by developing comparative models for violence and rates of alcohol use disorders.* ***Design and Methods.*** *The study examines trends in postcode-level hospital admission data for assault and for alcohol use disorders over a 14 year period (n = 186) and their relationship with the density of three kinds of alcohol outlets. Fixed-effects models are developed to control for the differences between postcodes and for the overall trends in outlet density and morbidity rates.* ***Results.*** *The results of this study suggest that the density of alcohol outlets where the main activity is alcohol consumption (i.e. pubs) is positively related to rates of assault-related hospital admissions, while the density of off-premise alcohol outlets is related to the rate of alcohol use disorders.* ***Discussion and Conclusions.*** *These findings have significant implications for alcohol policies in Victoria, in particular pointing to the significant contribution of packaged alcohol outlets to both acute and chronic alcohol-related harm.* [Livingston M. Alcohol outlet density and harm: Comparing the impacts on violence and chronic harms. *Drug Alcohol Rev* 2011;30:515–523]

Key words: alcohol availability, outlet density, violence, chronic disease.

Introduction

There is a large body of literature examining the links between the density of alcohol outlets and alcohol-related harm [1–3]. Cross-sectional studies have focussed particularly on violence (e.g. [4–8]). These studies have consistently found that the density of alcohol outlets in a particular area is positively associated with the rate of violence in that area. Despite this overarching consistency, detailed results contain substantial variety, with bars [9] and pubs [5], off-premise outlets [10] and both types (sometimes in differing ways) [7,11] significant in various studies. Studies of other outcomes, such as child maltreatment [12], public disturbances [13], road accidents [14] and general injuries [15] have similarly found evidence that areas with higher densities of alcohol outlets have higher rates of acute alcohol-related problems. Early research in this area considered chronic alcohol problems, such as alcoholism, and found some evidence that alcohol availability influenced rates of these problems [16–19]. However, these studies often used broad geographical units, such as cities or states rather than the community-level units and their results are thus more susceptible to the influence of cultural and political factors not included in their analyses. Only one community-level analysis has examined the links between alcohol outlet density and chronic alcohol-related problems, finding that off-premise alcohol outlet density was positively associated with rates of self-reported liver disease [20]. 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.

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Increasingly, longitudinal studies, which provide a more rigorous test of the relationship between the density of alcohol outlets and alcohol-related problems, are being undertaken in this field. Again, these studies have focussed predominantly on violence and other acute harms related to alcohol. In two similar studies, Gruenewald and Remer [21] and Livingston [22] used fixed-effects models to show that gradual changes in the density of alcohol outlets (both on- and off-premise) in a community were associated with corresponding changes in community-level rates of violence. Yu et al. [23] made use of a natural experiment in Los Angeles, following the surrender of nearly 300 liquor licences following the 1992 civil unrest. Their study examined trends in violent crime in census tracts where at least one licence had been surrendered compared with those where no outlets closed, finding that a 10% reduction in alcohol outlets was associated with a 2.6% reduction in violence. Three longitudinal studies have examined outcomes other than violence. Examining child maltreatment, Freisthler and Weiss [24] found evidence over 4 years that outlet density and child abuse and neglect were positively related. In a study using the same natural experiment as that used by Yu et al. [23], Cohen et al. [25] demonstrated that gonorrhoea rates declined when the number of alcohol outlets in a neighbourhood was reduced. Finally, Treno et al. [26] used 6 years of data from Californian zip codes to analyse the link between alcohol availability and alcohol-related vehicle accidents over time, finding that increases in bars and off-premise outlets were significantly related to crash rates.

However, there remains little theoretical clarity as to how this relationship actually functions. The simplest theoretical justification for the relationship between alcohol outlet density and alcohol-related harm is an economic one: that increasing the number of alcohol outlets reduces the real cost of alcohol (incorporating the convenience cost of making a purchase, along with the monetary price), thus increasing consumption and related problems [27,28]. This is supported in part by studies demonstrating local-level links between the density of alcohol outlets and alcohol consumption, including total consumption [29] and risky drinking [30–34], although other studies have produced contrasting results [35–38]. Stockwell and Gruenewald [39] attempted to add some nuance to availability theory, 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 [40], 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 that increase the likelihood of people's routine activities resulting in situations where alcohol-related problems are more likely to occur. This basic theory is refined slightly by Parker [41], who put forward the idea of clusters of licensed premises as 'great attractors', which attract motivated offenders and potential victims to the same locality. Gruenewald [42] took this idea further, proposing that increasing the number of liquor licences produces increasingly selective niche drinking environments, clustering together likeminded people, thus increasing the confrontations between violence-prone drinkers. This theory also explains the distribution of problems across venues, with a minority of licensed premises experiencing a large proportion of violence [43].

While these theories all provide some insight into the effects of alcohol outlet density on acute problems, such as violence, they seem 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 [21,22]. Freisthler et al. [44] 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 [1]. 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 outlets contribute differently to different types of harms. As Freisthler et al. [44] 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 to the costs of the service environment for on-premise

drinking), which may also influence how the densities of different outlet types influence harm.

Thus, in an attempt to develop a broader empirical basis for developing theories relating alcohol outlet density and alcohol-related problems, the current study 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 predominantly focussed on on-premise drinking (pubs) is related to rates of violence.
   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. That the density of off-premise alcohol outlets is related to rates of chronic alcohol-related disease. Changes to the density of off-premise outlets are most likely to reduce the real costs of alcohol for people who cannot easily plan their purchases and consumption ahead of time. This might provide some rationale for the consistent findings of effects of density on youth drinking but not adult drinking [30,32–34]. In addition, the reduced convenience costs relating to higher densities of off-premise alcohol outlets may have greater impact on drinkers who consume alcohol in problematic ways (e.g. dependent drinkers). It is likely that these drinkers source much of their alcohol from cheaper off-premise outlets and thus it is likely that changes in the density of these outlets will affect rates of the chronic harms associated with very heavy drinkers.

Method

This study uses an ecological design, based on postcode-level data from Melbourne, Australia's second largest city. Data on liquor licences, hospitalisations and socioeconomic 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. Postcodes generally represent local communities, although in the outer areas of the city, some include substantial non-residential areas, such as state parks, airports and industrial zones. All measures except for the index of socioeconomic disadvantage are rates per 1000 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. The licensing data include postcode information for each premise and this field was used to assign premises to postcodes for the analysis. A random selection of 200 licences were checked in detail using address fields to ensure that the postcode data were accurate, with results demonstrating 98% accuracy. Three categories of liquor licences were used in the analysis: general, packaged and on-premise. These licences make up around 80% of all licences in the study area over the period examined, with the rest made up of club licences, wholesalers and wineries. 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 3664 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 1024 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 hospital admissions data sourced from the Victorian Admitted Episodes 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 [45,46].

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 1 for the full list of diagnoses included in this category. (Note that alcoholic pancreatitis is not included, as it was not specifically coded in ICD-9.)

Postcode of residence is a compulsory field in the VAED, so all hospital admissions were associated with a region. A small proportion of admissions were for

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Table 1. *Diagnoses and ICD codes classed as alcohol-related 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

ICD, International Classification of Diseases.

patients who report invalid postcodes or have no fixed abode (~1.5%), and these admissions were excluded from this analysis.

Demographic data. The postcode population data were based on resident counts from census data from 1991, 1996, 2001 and 2006 [47,48] as well as Estimated Residential Population figures for 2007 [49]. Population data for 1994–1995, 1997–2000 and 2002–2005 were linearly interpolated.

Very few demographic data were available longitudinally at the postcode level, so only a single composite measure of socioeconomic disadvantage is included as a control variable. The Australian Bureau of Statistics produces the Socio-Economic Indexes for Areas (SEIFA) using data from each Census, and the Index of Relative Socio-Economic Disadvantage (IRSED) from the 1996, 2001 and 2006 Censuses has been used in this study. The IRSED is a composite score (with a range between around 700 and 1150) based on numerous variables, including educational attainment, household income and single-parent families. This measure provides an overall estimate of the socioeconomic 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 [50]. 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 socioeconomic disadvantage is imprecise, it provides some control for the effects of changes over time in the socioeconomic 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 1000 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 1000 residents, number of on-premise outlets per 1000 residents, number of general outlets per 1000 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 domestic violence rates.

The main aim of the study was to determine how outlet density at a postcode level was related to hospitalisation rates over a 14 year period. Time-series methods generally require many more time points, thus the analysis for this study was undertaken using a cross-sectional time-series approach. In this style of analysis, the replications across postcodes make up in statistical power for the shortness of the time-series. This study utilised a fixed-effects model, with fixed effects for each postcode and each year included in the model. Fixed-effects models focus on maximising the explained variance within units, reducing the possibility that cross-sectional differences between units will bias the results. The incorporation of fixed-effects for the years as well as the geographical units ensures that the results of the model are not unduly influenced by city-wide trends.

Because this study was based on geographical units, it was necessary to pay attention to the potential for non-independence between units. Studies using spatial data can violate the key assumption of unit independence because of the presence of spatial autocorrelation in the data. This occurs when data in one area are related in some way to data in neighbouring areas [7]. In other words, the data are not randomly distributed across the spatial units, with similar data clustered in neighbouring postcodes. If spatial autocorrelation is present in the data but not controlled for in analyses, the standard errors of the regression results can be substantially biased downwards, thus increasing the likelihood of falsely significant findings. Thus, this study used a spatial fixed-effects modelling procedure based on maximum likelihood estimators to ensure that non-biased regression results were produced. 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. These models were developed using the Matlab spatial econometrics toolbox developed by Paul Elhorst [51].

Table 2. *Descriptive statistics of study measures*

	Mean	SD	Min	Max	Total change	Proportion postcodes decreasing
Assault hospitalisations (per 1000)	0.80	0.69	0	7.79	43%	25%
Chronic alcohol hospitalisations (per 1000)	1.36	1.74	0	16.79	164%	20%
General licence rate (per 1000)	0.44	1.51	0	22.74	21%	37%
On-premise licence rate (per 1000)	1.04	2.74	0	40.21	154%	7%
Packaged licence rate (per 1000)	0.29	0.22	0	1.04	42%	21%
Index of Relative Socio-Economic Disadvantage	1032.4	77.2	707.0	1162.5	−1%	66%
Population (/1000)	15.6	10.1	0.4	56.0	16%	17%

Table 3. *Fixed-effects model results, relationship between assault hospitalisations and alcohol outlet density, 1994–2007, separate models for each licence category*

	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 1000)	0.129	<0.001	0.539	<0.001	0.062	<0.001
Index of Relative Socio-Economic Disadvantage	−0.003	<0.001	−0.002	<0.001	0.003	<0.001
Population (/1000)	−0.001	0.156	−0.002	0.110	−0.002	0.049

Results

Descriptive statistics of the measures used in this study are presented in Table 2. A key concern with analyses such as these is that there is sufficient variation over time in the measures across the study units. While all 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.

The results of the first set of fixed-effects models are presented in Table 3. 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 0.538 in assault hospitalisations. Contrastingly, the effects for general (0.129) and on-premise (0.062) licences were relatively small.

The results of the second set of fixed-effects models are presented in Table 4. 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 5 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 1000 residents is associated over time with an increase in assault hospitalisations of 0.115 per 1000 residents, while a unit increase in the packaged licence rate is associated with an increase of 0.213 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 increased in areas where socioeconomic disadvantage has increased.

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

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Table 4. *Fixed-effects model results, relationship between chronic hospitalisations and alcohol outlet density, 1994–2007, separate models for each licence category*

	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 1000)	0.124	<0.001	1.175	<0.001	0.081	<0.001
Index of Relative Socio-Economic Disadvantage	0.001	0.075	0.001	0.026	0.005	0.207
Population (/1000)	0.003	0.298	0.005	0.088	0.003	0.284

Table 5. *Fixed-effects model results, relationship between assault and chronic alcohol-caused hospital admissions and alcohol outlet density, 1994–2007*

	Assault hospitalisations		Chronic alcohol-caused hospitalisations	
	Effect size	*P*-value	Effect size	*P*-value
General licence rate (per 1000)	0.115	<0.001	−0.055	0.219
On-premise licence rate (per 1000)	−0.002	0.849	0.071	0.005
Packaged licence rate (per 1000)	0.213	<0.001	0.874	<0.001
Index of Relative Socio-Economic Disadvantage	−0.003	<0.001	0.001	0.109
Population (/1000)	−0.001	0.384	0.005	0.092

other licence categories (Table 5). Packaged liquor outlets remained the most influential, with an increase of 1 packaged outlet per 1000 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 2), 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 was significantly related to chronic alcohol-caused hospital admissions.

Discussion

The results of this study provide some support to the hypotheses outlined above. As expected, the density of general (pub) licences was significantly related to rates of assault and packaged liquor density was related to chronic disease. These results provide some support for the Freisthler's routine activity theory, with outlets associated with 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 do not 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 treatment in an 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. The relationship between general licence density and violence was expected, and reinforces previous results found using police data [5,22]. 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 cannot disentangle the precise mechanism linking violence and general

licence density, these results are also consistent with Gruenewald's assortative drinking extension of routine activities [42].

Contrary to the study's hypotheses, packaged liquor was also associated with violence rates. While this was not 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 does not 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 other studies that packaged liquor and domestic violence are related [52], although this is not a consistent finding [4]. This study is not the first to find a longitudinal relationship between packaged liquor outlets and general violence rates (e.g. 21, 22), although the mechanism for this relationship remains unclear [53], and there has been little discussion of domestic violence. Some authors from the USA have highlighted the link between packaged liquor, drug markets and other risky behaviours, such as gang activity [25,54], which may explain the relationship in cities in the USA. Recent concerns about late-trading packaged liquor outlets [55] and the use of off-premise alcohol to 'preload' [56] provide some further pointers to possible explanations of these relationships, but there has been little research into these issues in an Australian context, and very little is known about packaged liquor outlets to 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. The link between packaged liquor density and chronic disease also lends some support to the idea that changes in the availability of alcohol have larger impacts on vulnerable drinkers than on drinking in the general population [57]. Based on survey data (which should be treated with caution), 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 [58]. However, the results of this study demonstrate quite strong associations between increases in packaged liquor availability and chronic alcohol-related disease, which occur disproportionately among disadvantaged and vul-

nerable sections of the population [59]. 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.

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. Regardless, a relationship between these kinds of venues and chronic alcohol-related disease is counter-intuitive. On-premise alcohol is more expensive than packaged liquor and restaurants (which make up the majority of the on-premise licences) are unlikely to be sites of particularly heavy drinking in comparison with general licences (pubs). Thus, this result may be explained by an unmeasured factor, correlated with both on-premise licences and chronic alcohol problems, although there is no obvious candidate to fulfil this role.

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 1 year will most likely affect rates of chronic disease over a period of time longer than the single year being considered. Thus, the findings presented here should be considered a lower estimate of the actual effects on chronic disease.

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 quite crude, not taking into count variation within licence types. 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 socioeconomic 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 [21], are not controlled for in the current analysis. Thus, these results provide only a broad picture of the relationship between alcohol outlets, violence and chronic disease. Further data on

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alcohol sales, opening hours, capacity and venue style as well as more detailed sociodemographic data could provide further insight into these relationships.

Furthermore, the current study is limited by the use of only a single demographic control variable (socioeconomic disadvantage) at the local level. It is plausible that changes to the age structure or gender breakdown over the time-period studied will have influenced rates of the two outcome variables examined here. Unfortunately, these data were unavailable for inclusion in this study, and future work is necessary to test their influence on these findings.

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 were 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. [60]), 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.

Acknowledgements

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