

Accessibility to alcohol outlets and alcohol consumption

Findings from VicLANES

Professor Anne Kavanagh
Ms Lauren Krnjacki



THE UNIVERSITY OF
MELBOURNE

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Published in December 2011 by the
Victorian Health Promotion Foundation (VicHealth)

PO Box 154 Carlton South, VIC 3053 Australia

ISBN: 978-1-921822-43-8

Publication number: K-034-ATUV

Suggested citation

Accessibility to alcohol outlets and alcohol consumption: Findings from
VicLANES. Victorian Health Promotion Foundation (VicHealth), Carlton, Australia.

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Professor Anne Kavanagh and Ms Lauren Krnjacki

Centre for Women's Health, Gender and Society
Melbourne School of Population Health
The University of Melbourne



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1. Summary of project

The Victorian Lifestyle and Neighbourhood Environment Study (VicLANES) was conducted in late 2003. As part of that study, detailed information was collected from over 2500 participants in 50 census collector districts (CCD) in Melbourne about their alcohol consumption patterns. An audit was conducted on all outlets selling liquor for off-premise consumption, and the availability and price of 70 different alcoholic beverages were recorded. Using these data, we are able to assess the extent to which access to alcohol stores and the range and price of alcoholic beverages within stores influences whether individuals drink at levels associated with harm. In this report, we overview the current literature, present the main findings from the analysis of these data and make some recommendations for future research and policy.

The findings presented in this report have also been written up as journal articles that are currently under review or in preparation.

Objectives

In this report we address two key questions:

- Does accessibility to alcohol outlets close to home increase harmful alcohol consumption?
- Do the price and availability of a range of alcoholic beverages in alcohol outlets close to home increase harmful alcohol consumption?

Funding

This analysis was funded by a VicHealth grant of \$13,505.92, plus GST

2. Plain language summary

Using data collected in VicLANES of 2,334 adults living in 49 small areas in metropolitan Melbourne, we investigated whether access to alcohol outlets that sold liquor for consumption off premises influenced whether individuals consumed alcohol at levels associated with short- or long-term harm, as well as the frequency of consumption. We used four measures of access:

- density: the number of stores within a one-kilometre road network distance of respondents' homes
- proximity: the distance from a respondent's home to their closest store measured along a road network
- availability: the number of beverages stocked in the closest store out of a possible 70 items audited
- price: the price of a commonly stocked basket of beverages in the closest store.

We found that having access to a greater number of outlets increased the risk of drinking at levels associated with short-term harm. Having eight or more stores within in a one-kilometre network distance of respondents' home more than doubled the odds of consuming alcohol at levels associated with short-term harm at least weekly. We found some limited evidence that increased availability of a range of alcoholic beverages in the stores closest to respondents' homes actually reduced the risk of consuming at levels associated with long-term harm.

We recommend that policy makers consider the introduction of interventions to restrict the number of outlets in areas. We also recommend that policy interventions to reduce alcohol consumption, such as legislation limiting the number of new licenses or increasing the price of beverages, be rigorously evaluated. We note that we did not collect data on premises that sell alcohol for consumption on site, and recommend that this could be an area of future research.

The findings of the analysis on the density and proximity of alcohol outlets and consumption at levels associated with harm has been published previously (see Kavanagh AM, Kelly MT, Krnjacki L, Thornton L, Jolley D, Subramanian SV, Turrell G, Bentley RJ. [Access to alcohol outlets and harmful alcohol consumption: a multi-level study in Melbourne, Australia](#). *Addiction*. 2011 Oct;106(10):1772-9)

3. Background

Alcohol use is associated with a wide range of health and social problems, and thus there is considerable interest nationally and internationally to develop interventions to reduce the consumption of alcohol at levels associated with harm (National Preventative Health Taskforce 2008; World Health Organization 2007). The consequences of binge drinking, or drinking a large number of drinks on one occasion, include injuries, assaults and self-harm. Drinking at high levels over the longer term is associated with an increased risk of chronic diseases, such as liver disease, pancreatitis and cardiovascular disease (National Health and Medical Research Council 2001, 2007; World Health Organization 2007). Although there is considerable research demonstrating individual predictors of hazardous alcohol use, including being male (Australian Institute of Health and Welfare 2007), low socioeconomic position (Menvielle et al. 2007), younger age (Australian Institute of Health and Welfare 2007; Hibell et al. 2004) and Indigenous status (Australian Institute of Health and Welfare 2007), there has been less research on the impact of accessibility to alcohol outlets on consumption. The National Alcohol Strategy 2006–2011 (*National Alcohol Strategy 2006-2011* 2006) identifies restrictions on the economic and physical availability of alcohol as ways to potentially reduce harmful drinking behaviours. It recommends that future research investigates whether reducing geographic and economic access to alcohol decreases the risk of harmful alcohol consumption. This evidence could then be used to inform future research in the field.

Developed countries, such as Australia, have either introduced, or are considering, legislation to restrict the number of alcohol outlets, particularly those selling liquor for off-premise consumption (Liquor Control Advisory Council 2007). However, there is little evidence to support this strategy, particularly from countries other than the USA (Chikritzhs et al. 2007).

There have been a number of price-related policy initiatives in Australia, France, Switzerland, Germany and Denmark (Anderson & Baumberg 2006; The Honourable Nicola Roxon MP) that have been introduced, with the intent of reducing risk of harmful alcohol consumption. For example, in 2008, the Australian Government increased the tax on premixed spirits, and in 2009, reported a subsequent decline in the sale of these alcoholic products (The Honourable Nicola Roxon MP). We briefly review the evidence on access to alcohol environments and consumption of alcohol at levels associated with harm. First, we discuss research findings about access to alcohol outlets and harmful consumption. Second, we summarise findings on the effects of price and availability of alcohol within stores on consumption.

3.1 Access to alcohol outlets selling products for off-premise consumption

The relationship between access to off-premise alcohol outlets and consumption has generated mixed evidence. Some studies have found higher levels of drinking in areas with a higher density of off-premise outlets (Kypri et al. 2008; Schonlau et al. 2008). A study conducted by Livingston et al. (Livingston, Laslett & Dietze 2008) in Melbourne found that the density of off-site alcohol outlets was associated with an increased prevalence of high-risk drinking in young adults between the ages of 16 and 24 years. In New Zealand, a national study found that the density of outlets was associated with increased binge drinking and alcohol-related harm (Connor et al. 2010). Pollack et al. (Pollack et al. 2005); however, did not find evidence to support an association between density and consumption in the USA. Two studies examined whether residents' proximity to the nearest alcohol outlet influenced consumption, but neither study found evidence to support an association (Pollack et al. 2005; Scribner, Cohen & Fisher 2000).

Studies to date have had considerable limitations, particularly in relation to how exposure to alcohol outlets has been defined. The most frequent measure of outlet density is the absolute number of outlets in a specified area (Chen, Grube & Gruenewald 2010; Gruenewald, Johnson & Treno 2002; Livingston, Laslett & Dietze 2008; Nelson 2008; Pollack et al. 2005). This approach best represents the exposure of residents at the centre of an area, with misclassification more likely for residents closest to the boundary (Hewko, Smoyer-Tomic & Hodgson 2002; Matisziw, Grubestic & Wei 2008). A more accurate reflection of the number of stores near an individual's residence is the number of stores that fall within a specified distance from the residence. Road network distances provide better measures than Euclidean or straight-line measures of access. Previous studies have not used this approach, with the exception of Schonlau et al., who found a stronger association between alcohol density and consumption when network distance was used, as compared to the absolute number of outlets in census tracts (Schonlau et al. 2008).

3.2 Price and availability of alcoholic beverages

There is a large body of literature that addresses the relationship between alcohol price and consumption; however, the majority of these studies have been ecological and have assessed the relationship between the price (or taxes as a proxy for price) of beverages and consumption. A recent systematic review and meta-analysis of this literature found that alcohol prices and taxes

are related inversely to drinking (Wagenaar, Salois & Komro 2009). We are unaware of any studies that have used a multilevel study design to assess the relationship between the price of beverages and consumption. In VicLANES, we have the capacity to identify the price of a range of beverages for stores that are closest to home.

3.3 VicLANES

This study uses data from VicLANES, conducted in Melbourne, Australia in 2003. The study was approved by the La Trobe University Human Research Ethics Committee. The approval included approval for access to the Australian electoral roll, which lists the name, residential address and age of each registered voter. The aim of VicLANES was to examine the importance of individual and area-level characteristics in relation to three health behaviours: household food purchasing, physical activity and alcohol consumption (Kavanagh et al. 2007).

4. Methods

We discuss how we collected data on individuals and alcohol environments.

4.1 Selection of VicLANES areas and participants

VicLANES used a two-stage cluster design to select areas and individuals.

The first stage involved the sampling of 4170 CCD from the 21 innermost local government areas (LGA) in Melbourne. These LGA were situated in an approximately 20-kilometre radius from the central business district of Melbourne. CCD are used by the Australian Bureau of Statistics to collect population census data, and were the smallest geographic area defined in the Australian Standard Geographical Classification in 2001 (Australian Bureau of Statistics 2006). CCD in the sampling area had an average of 557 residents, and a mean size of 0.34 square kilometres. All CCD located within the LGA were ranked according to the proportion of households with a weekly pretax income of less than \$400/week (low-income households). CCD were subsequently stratified into septiles based on this ranking, and a random sample of 50 CCD from the highest (17 CCD), middle (16 CCD) and lowest (17 CCD) strata were selected.

4.2 Collection of environmental data

Collection of data on location of stores

The names and addresses of all alcohol outlets in Victoria that sold alcohol for consumption off premises were obtained from the Victorian Liquor Licensing Authority (Liquor Licensing Victoria 2002), and a field audit was conducted to verify the accuracy and completeness of the list. We geocoded all alcohol outlets that sold liquor that could be consumed off premises within a catchment area of 2-kilometres' Euclidian distance of the centroid of the selected CCD. This catchment area captured all outlets within a 1-kilometre road network distance of all participants' homes.

In-store audits of price and availability

Trained field auditors attended all stores to confirm the store was trading and selling liquor for off-site consumption. They also conducted a stocktake of presence and price of 70 different alcoholic beverages.

4.3 Collection of individual data

Sampling of individuals and response rate

We used the Australian electoral roll to identify all households in the selected CCD who had at least one adult aged between 18 and 75 years (it is compulsory for all persons aged 18 and over to vote, and it is estimated that 97.7 per cent of persons eligible to vote are enrolled (Australian Electoral Commission 2005). We randomly selected one person in a household when there was more than one eligible adult. Four thousand and five individuals were sampled. A postal survey was used to collect individual and household data. A tailored design method for mail surveys was used in order to maximise response rates to the postal survey (Dillman 2000). Valid responses were obtained from 2,349 respondents, equating to a response rate of 58.7 per cent (54.6 per cent in the most disadvantaged septile, 59 per cent in the middle septile and 62.1 per cent in the most advantaged septile).

Participation rates were inversely associated with area disadvantage, with high SES strata areas having higher rates than mid and low SES strata areas. We obtained census data for the included CCD, and our sample had a lower proportion of households in the lowest quintile of income, persons with no post-school qualification, blue collar workers, men and persons aged 18–24 years (data not shown).

4.4 Variables used in analysis

Outcome: alcohol consumption

The questions relating to alcohol consumption were based on the 2001 National Household Drug Survey (Australian Institute of Health and Welfare 2002). In the postal questionnaire, participants were asked if they ever consumed alcohol. If they responded 'yes', they were then asked:

- the frequency with which they consumed an alcoholic drink in the last 12 months, with eight response categories: everyday, five to six days/week, three to four days/week, one to two days/week, two to three days a month, about one day a month, less often and no longer drink
- how many drinks they usually consumed per drinking occasion, with six response categories: 13 or more, 11–12, seven to 10, five to six, three to four and one to two drinks
- the frequency with which they consumed alcohol at levels associated with short-term harm. Male respondents were asked how many times in the past year they consumed more than six standard drinks in a day, and females were asked the frequency with which they consumed more than four standard drinks. The response to this question included the same eight categories as the first question.

One standard drink was defined as 10 grams of alcohol, in accordance with the Australian National Health and Medical Research Councils (NHMRC) alcohol guidelines (National Health and Medical Research Council 2001). Pictures of typical serving sizes showing the equivalent number of standard drinks were used to help participants estimate their consumption. We used the NHMRC alcohol consumption guidelines (National Health and Medical Research Council 2001) to derive the outcome variables of harmful consumption outlined below:

Short-term harm (weekly and monthly)

Short-term harm was defined as more than six drinks for men, and more than four drinks for women. We computed two short-term harm variables, which referred to drinking at levels associated with short-term harm, at least once per week (short-term harm weekly), or at least once per month (short-term harm monthly).

Long-term harm

Long-term harm was computed by multiplying the responses to the first question with the responses to the second question, with mid-points used when the category included a range. Long-term harm was defined as 29 standard drinks or more per week for men, and 15 drinks or more per week for women.

Frequent consumption

We also derived a variable to represent the frequency of consumption, which was coded as 0=drink less often than five days per week, and 1=drinks on five or more days per week. This frequency of the consumption variable captured regular consumption, but did not necessarily represent frequent consumption at levels associated with harm.

Exposures: Access to alcohol

The locations of participants' homes were geocoded using ArcGIS version 9.3 (ESRI, Redlands, California, United States of America). There was a 100 per cent match rate, because the address data were obtained from the Australian electoral roll and were not self-reported. With regards to alcohol outlets, we again achieved a 100 per cent match rate, as the address data were sourced from Liquor Licensing Victoria, who requires a valid address prior to the issue of a license. For the network distance analysis, the types of roads were not considered, because we were interested in

driving distance, not driving time, which is where a consideration of road infrastructure and conditions are more important. Our road network analysis was configured so that restrictions were placed on one-way roads, and U-turns were permitted.

We did not include pedestrian walkways and alleys in the route options, as we were interested in the usual minimum travel distance by motor vehicle. Information obtained in the audit showed that all areas sampled had a reasonable quality of footpaths, so pedestrians would have had the option to travel along the same routes as motor vehicles.

Density

Density was calculated by counting the number of outlets within a 1-kilometre road network distance from the respondents' homes. We modelled density separately, as both a continuous and a categorical variable, to determine if there were potential threshold effects. Density was categorised as: no outlets, one outlet, two outlets, three to four outlets, five to seven outlets and eight or more outlets.

Proximity

Proximity was the road distance (in kilometres) from the respondents' homes to the nearest alcohol outlet. We modelled proximity as both a continuous and categorical variable to determine if there were potential threshold effects. Proximity was classified into the following categories: <0.4 kilometres, 0.4 to <0.8 kilometres, 0.8 to <1.2 kilometres and 1.2 or more kilometres.

Availability

Availability was defined as the number of available beverages in the audited stores (i.e. number could range from 1 to 70) that was closest to an individual's home. Availability was classified into the following categories: <40 items, 40–49 items, 50–59 items and 60 or more items.

Price

Price was estimated by calculating the price of a 'basket' of common items. These items represented the most commonly-available items across the different categories of alcoholic beverages (i.e. spirits, wine, beer). These items were: Jack Daniels whiskey, Stolichnaya vodka, Penfold's fortified wine, Four Sisters white wine, Wolf Blass red wine, Yellowglen sparkling, Carlton Cold beer, Cascade beer and Lemon Ruski (premix). There was a large amount of missing data, as not all items in the 'basket' were available

in all stores; however, we estimated the price of the full basket using multiple imputation (see the Appendix for further information on the statistical methods). Price was classified into categories of: <\$130, \$130 to <\$135, \$135 to <\$140 and >\$140.

Other covariates

We included a range of variables, which we hypothesised were likely to be confounders, as they could influence both where people live and their patterns of alcohol consumption. These were: individual socioeconomic position (education, occupation and household income), ethnicity (Australian born or not), age, sex and household composition.

4.5 Analytical approach

Residents living in the Melbourne central business district were removed from all analyses, due to the fact that this area was mainly commercial. All analyses were undertaken using the remaining 49 CCD, and included 2334 respondents. A small number of these respondents (193 respondents) were excluded from price and availability analyses, due to a very small number of available alcohol items in their closest store.

We estimated the proportion (and 95 per cent confidence intervals (95 per cent CI)) of people consuming alcohol at levels associated with harm (short-term weekly, short-term-monthly and long term), and frequent consumption, by a range of demographic variables. We tested for statistically-significant differences (at the 5 per cent level) between subgroups using χ^2 -test for nominal variables and tests for trend for ordinal variables.

We used multilevel logistic regression modelling because each outcome variable was dichotomous and to account for the clustering of individuals within CCD. The analysis was undertaken in Stata 11.1 (College Station, Texas, United States of America). Results from the multilevel analysis are presented as odds ratios (OR) with 95 per cent CI.

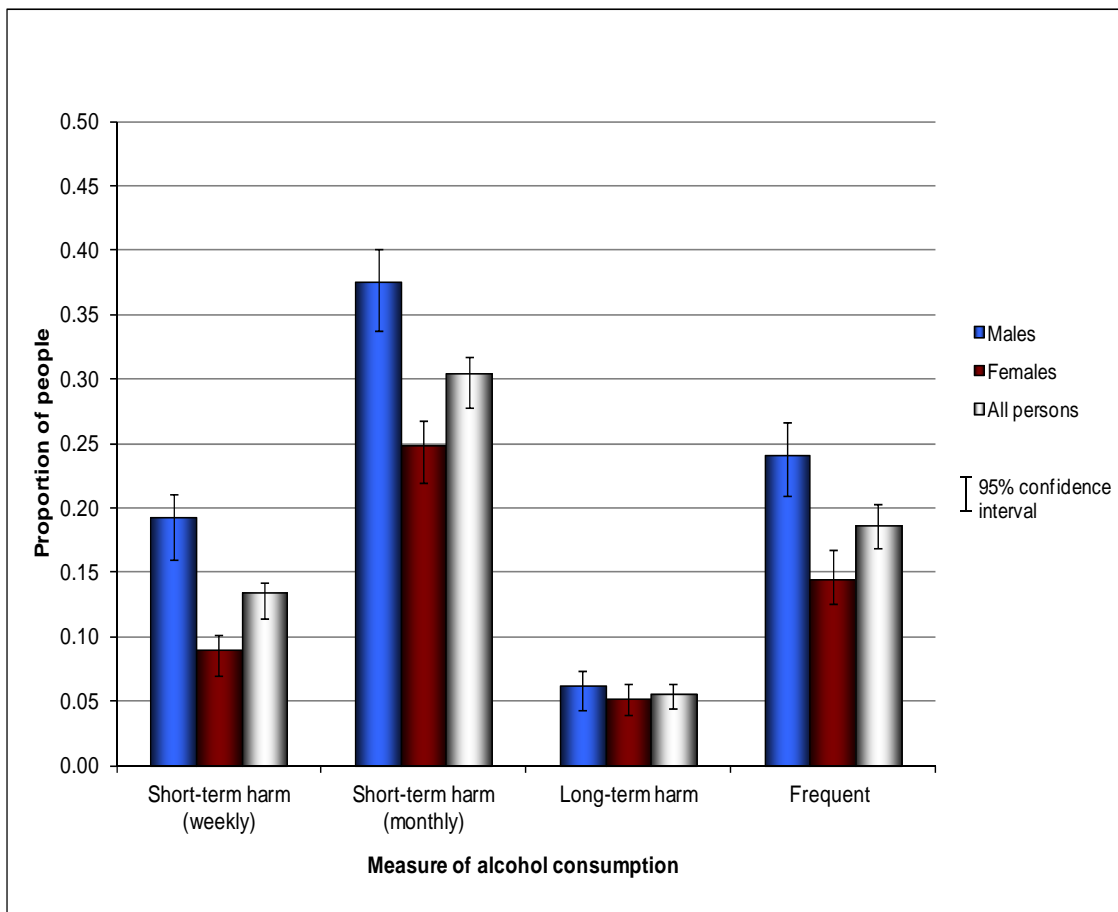
The alcohol access measures were modelled as continuous and categorical variables, with the lowest access category as the baseline (no outlets for density, 1.2 kilometres or more for proximity, less than 40 items for availability and <\$130 for price). All models were adjusted for potential confounders: age, sex, household composition, individual socioeconomic position (education, occupation, income) and area-level disadvantage.

5. Results

5.1 Prevalence of harms

The frequency of drinking at levels associated with harm varied across the measures (short-term harm, weekly, 13.5 per cent; short-term harm, monthly, 30.4 per cent; long-term harm, 5.5 per cent; and frequency of consumption, 18.7 per cent) (Figure 1).

Figure 1: Proportion of people consuming alcohol frequently, and at levels associated with harm



5.2 Demographics and alcohol consumption

Table A1 in the Appendix shows the association between demographic variables and alcohol consumption. Women were less likely to drink at harmful levels across all the alcohol consumption outcome measures. Alcohol consumption was also higher in households with only one adult, or two or more adults and no children. Drinking for short-term harm was more prevalent among

people in blue-collar occupations than those in professional occupations, and for respondents living in low-income households, compared with high-income households. Frequent alcohol consumption was more common in lower-income households, and also among those who were not working, and those in professional occupations. Consumption of alcohol at levels associated with short-term harm was more frequent in younger age groups, while frequent consumption of alcohol (five days a week or more) was more common in the older age groups. There was no clear relationship between area socioeconomic disadvantage and consumption of alcohol at levels associated with short- and long-term harm; however, residents living in the most advantaged areas were more likely to report frequent alcohol consumption (Table A1).

5.3 Distribution of alcohol environment measures

Table 1 shows the distribution of density, proximity, availability and price across the 49 CCD used in this analysis.

Table 1: Distribution of each alcohol environment measure

	Median	(Interquartile range)
Density	1store	(0 stores - 2 stores)
Proximity	790m	(500m - 1200m)
Availability	59 items	(54 items - 66 items)
Price	\$131	(\$128 - \$133)

5.4 Bivariate associations between alcohol environment and alcohol consumption

Table 2 shows the bivariate associations between measures of the alcohol environment and drinking at levels associated with harm.

Table 2: Associations between alcohol consumption and alcohol environment measures

Descriptive analysis based on 25,690 observations (imputed data)

Variable	Category (%)	Measure of Alcohol Consumption			
		Short-term harm (weekly)	Short-term harm (monthly)	Long-term harm	Frequent
		Harm % (95% CI)	Harm % (95% CI)	Harm % (95% CI)	Harm % (95% CI)
Density					
Nb stores	(38)	12 (10 - 14)	29 (26 - 32)	5 (4 - 6)	16 (14 - 19)
1	(26)	13 (10 - 16)	28 (25 - 32)	4 (3 - 6)	21 (17 - 24)
2	(14)	12 (8 - 15)	28 (23 - 33)	6 (3 - 8)	19 (14 - 23)
3 to 4	(10)	18 (13 - 23)	36 (30 - 42)	9 (5 - 12)	21 (16 - 27)
5 to 7	(9)	15 (10 - 20)	37 (30 - 43)	6 (3 - 10)	20 (14 - 26)
8+	(4)	25 (16 - 34)	41 (31 - 52)	9 (3 - 15)	19 (11 - 28)
Trend		P= 0.006	P= 0.004	P= 0.024	P= 0.211
Proximity					
1.2km+	(26)	12 (10 - 15)	30 (26 - 33)	4 (3 - 6)	16 (13 - 19)
0.8 to <1.2 km	(23)	13 (10 - 16)	31 (27 - 35)	6 (4 - 8)	18 (14 - 21)
0.4 to <0.8 km	(33)	13 (11 - 15)	28 (25 - 31)	6 (4 - 7)	21 (18 - 24)
< 0.4 kms	(17)	17 (14 - 21)	35 (30 - 40)	7 (4 - 10)	19 (15 - 23)
Trend		P= 0.264	P= 0.555	P= 0.107	P= 0.296
Availability					
< 40 items	(13)	15 (11 - 19)	32 (27 - 38)	9 (6 - 12)	22 (17 - 27)
40 to 49 items	(6)	9 (4 - 14)	25 (18 - 33)	2 (0 - 4)	11 (5 - 17)
50 to 59 items	(33)	13 (10 - 15)	29 (25 - 32)	5 (4 - 7)	21 (17 - 24)
60+ items	(48)	13 (11 - 15)	30 (28 - 33)	5 (4 - 6)	17 (15 - 20)
Trend		P= 0.814	P= 0.906	P= 0.090	P= 0.452
Price					
< \$130	(30)	13 (10 - 15)	27 (24 - 31)	6 (4 - 7)	20 (17 - 24)
\$130 to < \$135	(59)	12 (10 - 14)	30 (28 - 33)	5 (4 - 6)	17 (15 - 19)
\$135 to < \$140	(5)	20 (12 - 28)	37 (27 - 47)	8 (3 - 14)	23 (14 - 32)
\$140+	(6)	15 (9 - 21)	36 (27 - 44)	9 (4 - 14)	24 (16 - 31)
Trend		P= 0.319	P= 0.022	P= 0.193	P= 0.844

Density

As the number of alcohol outlets increased, the risk of consumption at levels associated with long-term harm and short-term harm, weekly, and short-term harm, monthly, increased (P for trend 0.024, 0.006 and 0.004, respectively) (Table 2).

Proximity

There were no statistically-significant associations between proximity and drinking at levels associated with harm but the highest levels of drinking for short-term harm (both weekly and monthly) were found in the respondents living closest to an outlet (Table 2).

Availability

There was no evidence to support an association between the availability of alcoholic beverages in stores and drinking at levels associated with harm (Table 2).

Price

The prevalence of drinking at levels associated with short-term harm, at least monthly, increased, as the price of the basket of alcohol increased (P = 0.022) (Table 2).

5.5 Multilevel regression analyses

Density

The density of outlets was linearly associated with increased risk of all measures of harmful alcohol consumption (Table 3). The risk of harmful consumption was highest when there were eight or more outlets (short-term harm, weekly: OR 2.36, 95 per cent CI: 1.12–4.54 and short-term harm, monthly: OR 1.80, 95 per cent CI: 1.07–3.04) (Table 3; Figures 2 and 3).

Table 3: Relationship between density of alcohol stores and alcohol consumption

Variable	Type of Harm			
	Short Term (weekly) OR (95%CI)	Short term (monthly) OR (95%CI)	Long Term OR (95%CI)	Frequent OR (95%CI)
<i>Categorical Measure</i>				
None	1.00	1.00	1.00	1.00
1	1.15 (0.79 - 1.66)	1.01 (0.77 - 1.32)	0.86 (0.51 - 1.45)	1.29 (0.95 - 1.76)
2	0.95 (0.60 - 1.50)	0.95 (0.68 - 1.33)	1.10 (0.60 - 2.01)	1.24 (0.84 - 1.81)
3 to 4	1.75 (1.12 - 2.76)	1.41 (0.99 - 2.00)	1.69 (0.95 - 3.01)	1.33 (0.88 - 1.99)
5 to 7	1.32 (0.79 - 2.21)	1.56 (1.07 - 2.28)	1.29 (0.65 - 2.57)	1.46 (0.94 - 2.28)
8+	2.36 (1.22 - 4.54)	1.80 (1.07 - 3.04)	1.47 (0.62 - 3.46)	1.36 (0.71 - 2.62)
<i>Test for trend</i>				
P Value	0.009	0.002	0.092	0.077

Table 4: Relationship between proximity to nearest alcohol store and alcohol consumption

Variable	Type of Harm			
	Short Term (weekly) OR (95%CI)	Short term (monthly) OR (95%CI)	Long Term OR (95%CI)	Frequent OR (95%CI)
<i>Categorical Measure</i>				
1.2+ kms	1.00	1.00	1.00	1.00
0.8 to <1.2 km	0.98 (0.65 - 1.48)	1.18 (0.86 - 1.63)	1.39 (0.80 - 2.44)	1.21 (0.83 - 1.77)
0.4 to <0.8 km	1.04 (0.70 - 1.57)	0.98 (0.73 - 1.33)	1.31 (0.77 - 2.25)	1.43 (1.03 - 2.00)
<0.4 kms	1.29 (0.81 - 2.05)	1.35 (0.95 - 1.91)	1.53 (0.84 - 2.81)	1.33 (0.87 - 2.02)
<i>Test for trend</i>				
P Value	0.309	0.278	0.219	0.083

Figure 2: Odds of consumption at levels associated with short-term harm (weekly) by number of stores (within 1-kilometre network distance) compared to no stores

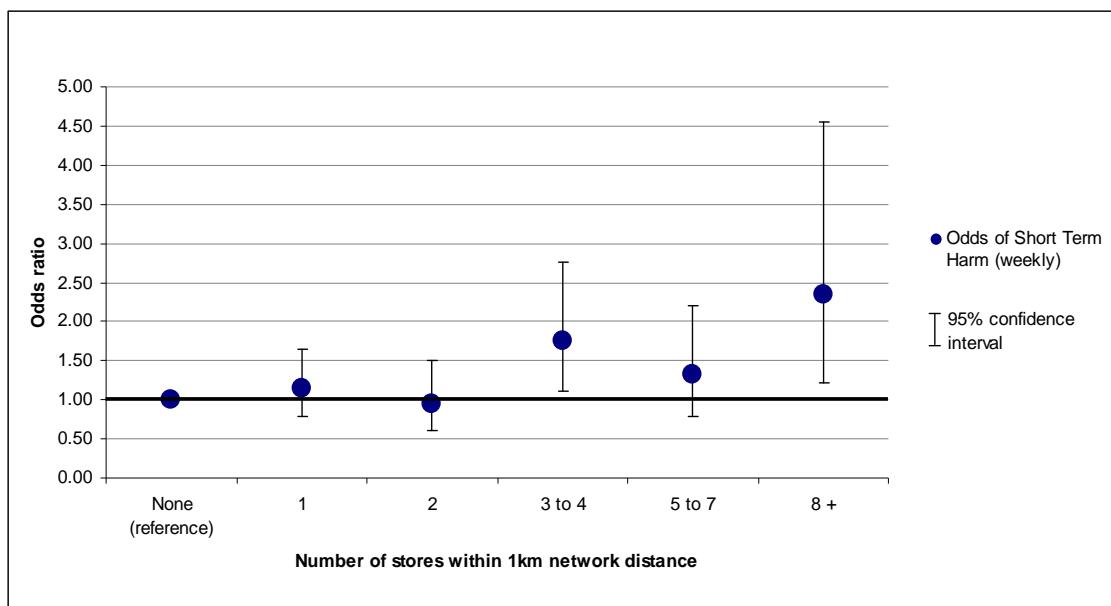
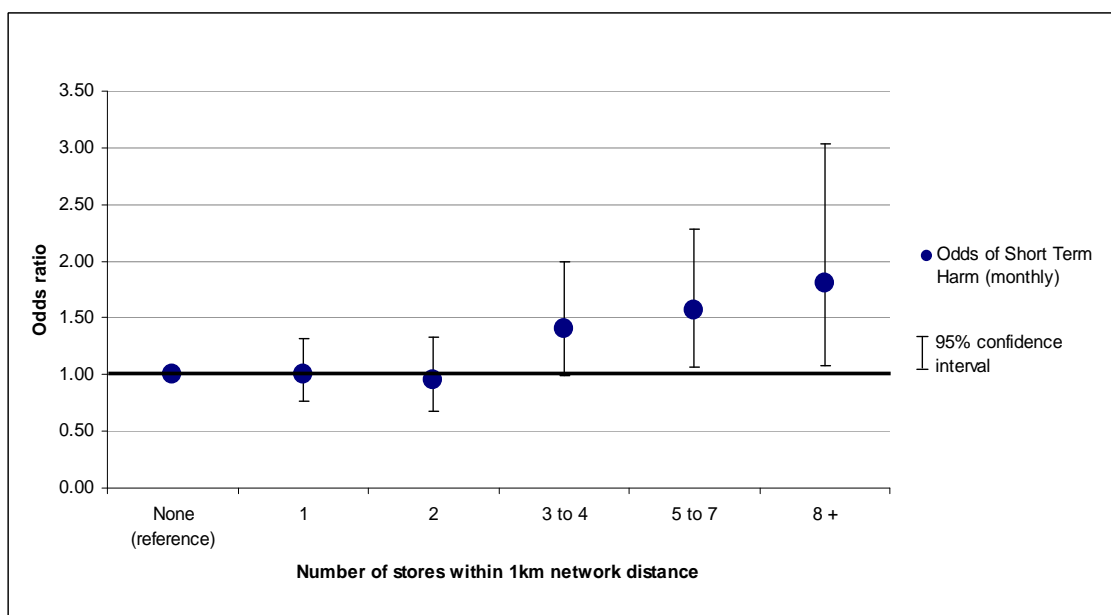


Figure 3: Odds of consumption at levels associated with short-term harm (monthly) by number of stores (within 1-kilometre network distance) compared to no stores



Proximity

We did not find evidence to support an association between proximity of alcohol outlets and alcohol consumption at levels associated with short- or long-term harm or frequency of consumption when proximity was fitted as a continuous or categorical variable (Table 4).

Table 5: Relationship between availability of items in nearest alcohol store and alcohol consumption

Variable	Type of Harm			
	Short Term (weekly) OR (95%CI)	Short term (monthly) OR (95%CI)	Long Term OR (95%CI)	Frequent OR (95%CI)
<i>Categorical Measure</i>				
< 40 items	1.00	1.00	1.00	1.00
40 to 49 items	0.45 (0.19 - 0.99)	0.71 (0.40 - 1.26)	0.20 (0.04 - 0.88)	0.67 (0.32 - 1.39)
50 to 59 items	0.81 (0.51 - 1.27)	0.84 (0.59 - 1.19)	0.57 (0.32 - 1.00)	0.93 (0.63 - 1.38)
60+ items	0.75 (0.48 - 1.14)	0.88 (0.64 - 1.23)	0.55 (0.33 - 0.94)	0.79 (0.53 - 1.18)
<i>Test for trend</i>				
P Value	0.450	0.748	0.101	0.325

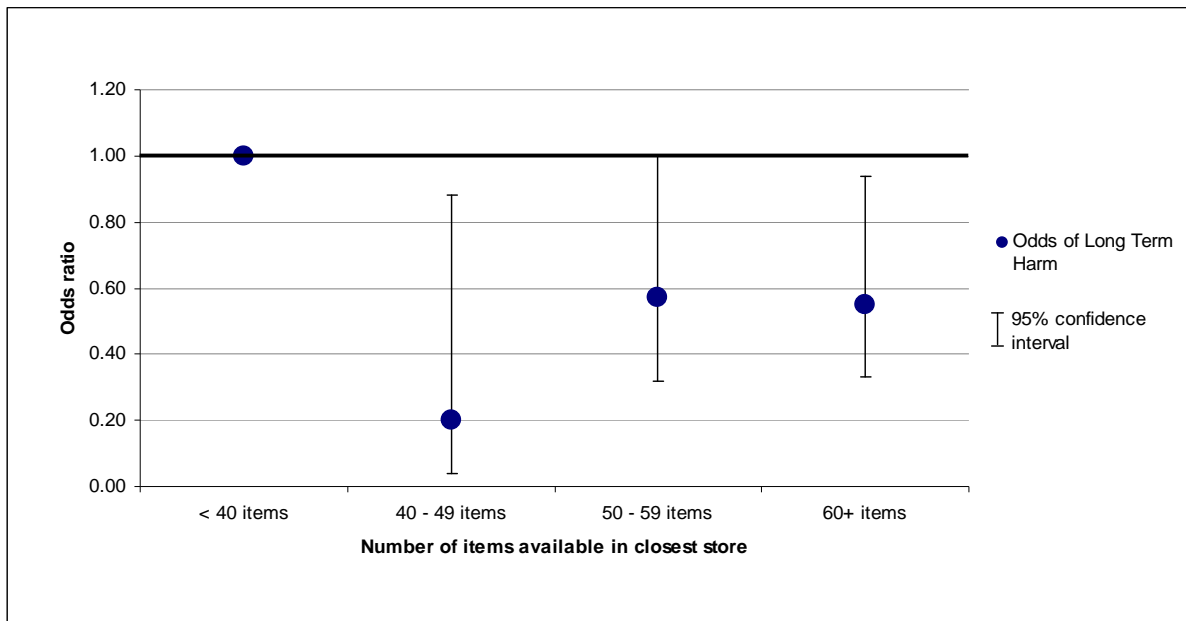
Table 6: Relationship between price of items in nearest alcohol store and type of harm

Variable	Type of Harm			
	Short Term (weekly) OR (95%CI)	Short term (monthly) OR (95%CI)	Long Term OR (95%CI)	Frequent OR (95%CI)
<i>Categorical Measure</i>				
< \$130	1.00	1.00	1.00	1.00
\$130 to < \$135	0.89 (0.65 - 1.23)	1.08 (0.85 - 1.38)	0.82 (0.53 - 1.28)	0.83 (0.66 - 1.09)
\$135 to < \$140	1.55 (0.82 - 2.92)	1.40 (0.83 - 2.35)	1.22 (0.52 - 2.84)	1.40 (0.79 - 2.48)
\$140+	1.29 (0.68 - 2.44)	1.41 (0.87 - 2.28)	1.42 (0.66 - 3.07)	1.08 (0.63 - 1.85)
<i>Test for trend</i>				
P Value	0.422	0.106	0.463	0.758

Availability

Although there was not a statistically-significant association between availability of alcoholic beverages and alcohol consumption at levels associated with harm, when availability was fitted as a continuous variable, when availability was fitted as a categorical variable, we found some evidence to suggest that access to a larger variety of beverages reduced consumption associated with long-term harm (Table 5; Figure 4).

Figure 4: Odds of consumption at levels associated with long-term harm by availability of items in nearest store, compared to 'less than 40 items'



Price

The price of a basket of alcohol beverages was not associated with consumption of alcohol at levels that increase risk of harm, when price was fitted as a continuous or categorical variable. The significant trend found between price, fitted as categorical variable, and short-term harm, monthly, found in the bivariate analysis, did not remain when controlling for potential confounders (Table 6).

6. Discussion

6.1 Discussion of findings

Density

Access to an increased number of alcohol outlets is associated with a higher risk of drinking at levels associated with harm. We found evidence to suggest that the association between outlet density and consuming alcohol at levels associated with short-term harm might not be strictly linear. When outlet density was fitted as a categorical variable, the increased risk of drinking at levels associated with short-term harm, at least weekly, was observed when there were three to four, and eight or more outlets within a one-kilometre network area. An increased risk of drinking at levels associated with harm, at least monthly, was observed when there were five or more outlets. We therefore find evidence to suggest that when the number of outlets in an area of a one-kilometre network distance is eight or more, the risk of drinking at levels associated with short-term harm (weekly and monthly) is increased. Although the association between outlet density and both frequent consumption and drinking at levels associated with long-term harm were not statistically significant ($P = 0.077$ for frequent consumption, $P = 0.092$ for long-term harm), the direction of the effects are suggestive of a positive association. As consumption at levels associated with long-term harm was less common than drinking at levels associated with short-term harm; this might have reduced our power to detect a statistically-significant effect. The lack of a significant association between outlet density and increases in 'average consumption' has also been reported by Connor et al. in a study conducted in New Zealand (Connor et al. 2010).

Proximity

Given that we found associations between outlet density and harmful alcohol consumption, the lack of evidence to support an association between proximity and consumption is surprising. The potential explanation for the lack of association between proximity and consumption might be due to the limited range of values for proximity in our sample, with 75 per cent of participants having an outlet within 1.2 kilometres of their home. This small exposure gradient might have limited our power to detect an association between proximity and consumption. However, our findings are consistent with other studies, whereby associations between outlet density and consumption have been reported (Kypri et al. 2008; Livingston, Laslett & Dietze 2008; Schonlau et al. 2008), while no studies have found an association between proximity and consumption (Pollack et al. 2005; Scribner, Cohen & Fisher 2000).

Availability

We found some limited evidence to suggest that access to a greater variety of alcoholic beverages reduced the risk of drinking at levels associated with long-term harm. Although this result might seem counterintuitive, the larger variety of beverages provides consumers with greater choice, and beverages with low alcohol content (e.g. light beers) might be more readily available. Further study is needed to investigate this association.

Price

In our study, there was no evidence of an association between the price of a basket of commonly-available items and levels of alcohol consumption. This finding does not accord with previous research, which has demonstrated that consumption is strongly related to price (Wagenaar, Salois & Komro 2009). However, most other studies have been ecological, or if based on individual outcome data, have used area-level measure of alcohol access. In addition, many of the individual-level studies have been conducted on youth populations that might be more sensitive to changes in price (Elder et al. 2010). We are unaware of any studies other than ours that have investigated this using multilevel modelling and individual measures of alcohol access.

One of the reasons we might have not found an association between price and consumption is that there was very little variability in the price of beverages between stores. It may be that consumption levels are affected by much larger fluctuations in price than we could test in this study.

6.2 Strengths and limitations

We discuss the strengths and limitations of this study, and summarise some of the complex methodological issues.

Limitations

First, it is possible that respondents self-selected into areas in such a way that people who are at risk of drinking at levels associated with harm might have also lived in areas with a higher density of outlets. This self-selection could potentially result in overestimates of the association between outlet density and consumption. However, people in higher socio-economic groups are more able to choose their place of residence, and we controlled for three measures of individual and household socio-economic position. Therefore, we believe it is unlikely that self-selection could account for the results. Second, we used a one-kilometre

network distance, which is approximately equivalent to a 15-minute walk or a five-minute car ride, and thus outlets at this distance would be highly accessible to people's homes. We fitted densities with higher buffer distances and found that they yielded similar but slightly attenuated results. Third, this study is cross-sectional, and thus we cannot conclude the associations are causal, as businesses that sell alcohol might set up in areas where there is already a high prevalence of people drinking at levels associated with harm. Intervention studies are needed to test the impact of changes in the exposure to alcohol outlets on changes in consumption. In addition, levels of alcohol consumption were self-reported, and it is likely that these were underestimated by respondents.

Strengths

The study has considerable strengths. First, our measures of access to alcohol outlets are more sophisticated than those used previously. We measure density and proximity using road network distance, calculated from respondents' homes, while previous studies used measures derived from administrative units or calculated using Euclidian distances. We also collected detailed information on the variety of beverages in stores and their prices. To our knowledge, this detailed information has not been collected previously in Australia. Second, we were able to control for a large number of confounders, including individual and area-level socioeconomic position and potential predictors of self-selection, thus minimising the possibility of residual confounding.

Summary of methodological issues

Some of the complex methodological difficulties are detailed in the Appendix. Briefly, these related to missing data on key socioeconomic variables, and the fact that many stores only stocked a limited range of beverages. This required us to conduct multiple imputation to obtain values for missing data items. Additionally, many of the CCD were very close to each other, and it is possible that measures of alcohol access and consumption might have been correlated across CDD. However, we conducted sensitivity analyses to address this problem, and concluded that it did not alter our estimates. Finally, it is possible that unmeasured characteristics of areas might confound the associations between alcohol access and consumption.

7. Recommendations

Based on our findings, we suggest that policy interventions that restrict the number of outlets selling liquor for off-premise consumption in areas could reduce consumption at levels associated with harm. We do not provide evidence to support policies that restrict the number of beverages that stores stock. In addition, we do not find evidence to support increasing the price of alcohol to reduce consumption; however, we believe that our study might not have been able to detect an association, because there was so little variation in the prices of beverages between stores.

We recommend that future research, possibly supported by VicHealth, assess the impact of policy interventions, such as limiting the number of alcohol licenses in areas or monitoring the impact of increases in the price of beverages. Furthermore, we did not assess whether access to outlets for on-premise consumption influenced the levels of consumption, and this is likely to be a fruitful area of future research.

In sum, we recommend that:

- policy makers and practitioners consider implementing strategies to reduce the number of stores that sell alcohol for off-premise consumption
- rigorous evaluation of policy initiatives to restrict access to stores or to increase the price of beverages is funded
- research that examines the impact of access to premises that sell alcohol consumption on site be funded.

8. References

- Anderson, P & Baumberg, B 2006, *Alcohol in Europe: a public health perspective. A report for the European Commission*, Institute of Alcohol Studies, London.
- Australian Bureau of Statistics 2006, *Census dictionary, 2006 (reissue)*, ABS, Canberra, <[http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/2901.0Contents12006%20\(Reissue\)?opendocument&tabname=Summary&prodno=2901.0&issue=2006%20\(Reissue\)&num=&view=>](http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/2901.0Contents12006%20(Reissue)?opendocument&tabname=Summary&prodno=2901.0&issue=2006%20(Reissue)&num=&view=>)>.
- Australian Electoral Commission 2005, *Measuring the accuracy of the electoral rolls and testing the effectiveness of the continuous roll update*, Australian Electoral Commission, Canberra.
- Australian Institute of Health and Welfare 2002, *National Drug Strategy Household Survey: first results*, AIHW, Canberra.
- 2007, *Statistics on drug use in Australia 2006*, AIHW, Canberra, DOI cat no. PHE 80.
- Chen, M, Grube, J & Gruenewald, P 2010, 'Community alcohol outlet density and underage drinking', *Addiction*, vol. 105, pp. 270-8.
- Chikritzhs, T, Catalano, P, Pascal, R & Hendrickson, N 2007, *Predicting alcohol-related harms from licensed outlet density: a feasibility study*, National Drug Research Institute & Western Australian Drug and Alcohol Office, Perth.
- Connor, JL, Kypri, K, Bell, ML & Cousins, K 2010, 'Alcohol outlet density, levels of drinking and alcohol-related harm in New Zealand: a national study', *Journal of Epidemiology and Community Health*, vol. 65, pp. 841-6.
- Dillman, D 2000, *Mail and internet surveys: the tailored design method*, 2nd edn, John Willey, New York.
- Elder, RW, Lawrence, B, Ferguson, A, Naimi, TS, Brewer, RD, Chattopadhyay, SK, Toomey, TL & Fielding, JE 2010, 'The effectiveness of tax policy interventions for reducing excessive alcohol consumption and related harms', *American Journal of Preventative Medicine*, vol. 38, no. 2, pp. 217-29.
- Gruenewald, P, Johnson, F & Treno, A 2002, 'Outlets, drinking and driving: a multilevel analysis', *Journal of Studies on Alcohol*, vol. 63, pp. 460-8.
- Hewko, J, Smoyer-Tomic, KE & Hodgson, MJ 2002, 'Measuring neighbourhood spatial accessibility to urban amenities: does aggregation error matter?', *Environment and Planning*, vol. 34, no. 7, pp. 1185-206.
- Hibell, B, Andersson, B, Bjarnason, T, Ahlstrom, S, Balakireva, O, Kokkevi, A & Morgan, M 2004, *The ESPAD report 2003: alcohol and other drug use among students in 35 European countries*, Swedish Council for Information on Alcohol and Other Drugs, Stockholm.
- Kavanagh, A, Thornton, L, Tattam, A, Thomas, L, Jolley, D & Turrell, G 2007, *Place does matter for your health: a report of the Victorian Lifestyle and Neighbourhood Environment Study*, University of Melbourne, Melbourne.
- Klebanoff, MA & Cole, SR 2008, 'Use of multiple imputation in the epidemiological literature', *American Journal of Epidemiology*, vol. 168, no. 4, pp. 355-7.
- Kypri, K, Bell, M, Hay, G & Baxter, J 2008, 'Alcohol outlet density and university student drinking: a national study', *Addiction*, vol. 103, no. 7, pp. 1131-8.
- Liquor Control Advisory Council 2007, *Report on the appropriateness of the regulatory regime for the sale of packaged liquor in Victoria: issues paper*, Consumer Affairs Victoria, Melbourne, <[http://www.consumer.vic.gov.au/CA256902000FE154/Lookup/CAV_Publications_Liquor_Licensing_2/\\$file/liquor_misc_packaged_liquor_issues_paper.doc](http://www.consumer.vic.gov.au/CA256902000FE154/Lookup/CAV_Publications_Liquor_Licensing_2/$file/liquor_misc_packaged_liquor_issues_paper.doc)>.
- Liquor Licensing Victoria 2002, *Licence details as at 8 December, 2002*, State Government of Victoria.

- Livingston, M, Laslett, A-M & Dietze, P 2008, 'Individual and community correlates of young people's high-risk drinking in Victoria, Australia', *Drug and Alcohol Dependence*, vol. 98, no. 3, pp. 241-8.
- Matisziw, TC, Grubestic, TH & Wei, H 2008, 'Downscaling spatial structure for the analysis of epidemiological data', *Computers, Environment and Urban Systems*, vol. 32, no. 1, pp. 81-93.
- Menvielle, G, Kunst, A, Stirbu, I, Borrell, C, Bopp, M, Regidor, E, Strand, BH, Deboosere, P, Lundberg, O, Leclerc, A, Costa, G, Chastang, J-F, Esnaola, S, Martikainen, P & Mackenbach, J 2007, 'Socioeconomic inequalities in alcohol related cancer mortality among men: to what extent do they differ between Western European populations?', *International Journal of Cancer*, vol. 121, no. 3, pp. 649-55.
- National Alcohol Strategy 2006-2011*, 2006, Ministerial Council on Drug Strategy.
- National Health and Medical Research Council 2001, *Australian alcohol guidelines: health risks and benefits*, Commonwealth of Australia, Canberra. <<http://www.nhmrc.gov.au/publications/subjects/substance.htm>>.
- 2007, *Australian alcohol guidelines for low-risk drinking: draft for public consultation*, Australian Government, Canberra.
- National Preventative Health Taskforce 2008, *Technical Report No 3: Preventing alcohol-related harm in Australia: a window of opportunity*, Australian Government, Canberra.
- Nelson, J 2008, 'How similar are youth and adult alcohol behaviours? Panel results for excise taxes and outlet density', *Atlantic Economic Journal*, vol. 36, no. 1, pp. 89-104.
- Pollack, C, Cubbin, C, Ahn, D & Winkleby, M 2005, 'Neighbourhood deprivation and alcohol consumption: does the availability of alcohol play a role?', *International Journal of Epidemiology*, vol. 34, no. 4, pp. 772-80.
- Schonlau, M, Scribner, R, Farley, T, Theall, K, Bluthenthal, R, Scott, M & Cohen, D 2008, 'Alcohol outlet density and alcohol consumption in Los Angeles county and southern Louisiana', *Geospatial Health*, vol. 3, no. 1, pp. 91-101.
- Scribner, R, Cohen, D & Fisher, W 2000, 'Evidence of a structural effect for alcohol outlet density: a multilevel analysis', *Alcoholism: Clinical and Experimental Research*, vol. 24, no. 2, pp. 188-95.
- The Honourable Nicola Roxon MP *Alcopops tax loophole finally closed*, Department of Health and Ageing: Canberra. 13 August 2009, <<http://www.health.gov.au/internet/ministers/publishing.nsf/Content/mr-yr09-nr-nr120.htm>>, accessed 1 March 2011>.
- Wagenaar, AC, Salois, MJ & Komro, KA 2009, 'Effects of beverage alcohol price and tax levels on drinking: a meta-analysis of 1003 estimates from 112 studies', *Addiction*, vol. 104, no. 2, pp. 179-90.
- World Health Organization 2007, *WHO Expert Committee on Problems Related to Alcohol Consumption: second report*, WHO, Geneva.

9. Appendix

9.1 Alcohol consumption and demographics

Table A1: Associations between alcohol consumption and demographics (descriptive analysis based on 25,690 observations (imputed data))

Variable	Category (%)	Measure of Alcohol Consumption			
		Short-term harm (weekly) Harm% (95% CI)	Short-term harm (monthly) Harm% (95% CI)	Long-term harm Harm% (95% CI)	Frequent Harm% (95% CI)
Sex					
Male	(44)	19 (17 - 22)	38 (35 - 41)	6 (5 - 8)	24 (21 - 27)
Female	(56)	9 (7 - 11)	25 (23 - 27)	5 (4 - 6)	14 (12 - 17)
χ^2		P= <0.001	P= <0.001	P= 0.001	P= <0.001
Aust Born					
No	(29)	6 (4 - 8)	16 (13 - 19)	3 (1 - 4)	17 (14 - 21)
Yes	(71)	17 (15 - 18)	36 (34 - 39)	7 (6 - 8)	19 (17 - 21)
χ^2		P= <0.001	P= <0.001	P= <0.001	P= 0.001
Household Type					
One adult	(18)	18 (14 - 22)	32 (28 - 37)	7 (4 - 9)	18 (14 - 22)
One adult, children	(6)	14 (8 - 20)	27 (29 - 34)	4 (0 - 7)	14 (8 - 20)
2 or more adults	(41)	16 (13 - 18)	36 (33 - 39)	7 (5 - 8)	20 (18 - 23)
2 or more adults, children	(35)	9 (7 - 11)	23 (20 - 26)	4 (3 - 5)	18 (15 - 21)
χ^2		P= <0.001	P= <0.001	P= <0.001	P= <0.001
Education					
Bachelor or higher	(32)	11 (9 - 13)	29 (26 - 32)	6 (4 - 8)	21 (18 - 24)
Diploma	(12)	8 (5 - 12)	26 (20 - 31)	3 (1 - 5)	19 (14 - 24)
Vocational	(20)	18 (14 - 22)	35 (31 - 40)	6 (4 - 8)	21 (17 - 25)
No post school	(37)	15 (13 - 17)	31 (27 - 34)	6 (4 - 8)	16 (13 - 18)
Trend		P= 0.002	P= 0.124	P= 0.560	P= 0.124
Occupation					
Professional	(36)	12 (10 - 14)	34 (30 - 37)	5 (4 - 7)	21 (18 - 24)
White Collar	(16)	15 (11 - 18)	35 (30 - 40)	6 (3 - 8)	12 (8 - 15)
Blue Collar	(12)	25 (20 - 30)	42 (36 - 48)	6 (3 - 9)	15 (10 - 19)
Not working	(35)	11 (9 - 13)	21 (18 - 24)	6 (4 - 8)	21 (18 - 24)
χ^2		P= <0.001	P= <0.001	P= 0.187	P= <0.001
Income (per annum)					
\$20,799 or less	(30)	14 (11 - 17)	38 (34 - 42)	6 (4 - 8)	23 (20 - 27)
\$20,800 to \$36,399	(20)	13 (10 - 17)	31 (26 - 36)	7 (4 - 9)	18 (14 - 22)
\$36,400 to \$51,999	(17)	13 (9 - 16)	29 (24 - 34)	5 (2 - 7)	17 (12 - 21)
\$52,000 to \$77,999	(17)	14 (11 - 18)	25 (21 - 30)	5 (2 - 7)	15 (12 - 19)
\$78,000 or more	(17)	13 (10 - 17)	23 (18 - 28)	5 (3 - 7)	16 (12 - 20)
Trend		P= 0.612	P= <0.001	P= 0.179	P= 0.012
Age					
18 to 24	(8)	23 (17 - 29)	55 (48 - 62)	8 (4 - #)	3 (1 - 6)
25 to 34	(18)	19 (15 - 22)	42 (37 - 47)	7 (4 - 9)	8 (5 - 10)
35 to 44	(21)	13 (10 - 16)	32 (28 - 36)	4 (2 - 6)	14 (11 - 17)
45 to 54	(21)	12 (9 - 14)	26 (22 - 30)	5 (3 - 7)	23 (19 - 26)
55 to 64	(17)	11 (8 - 14)	24 (20 - 28)	6 (3 - 8)	28 (23 - 32)
65+	(15)	10 (6 - 13)	15 (11 - 19)	5 (3 - 8)	30 (25 - 35)
Trend		P= <0.001	P= <0.001	P= 0.409	P= <0.001
Strata					
Most advantaged	(36)	11 (9 - 13)	29 (26 - 32)	5 (4 - 7)	24 (21 - 27)
Middle	(33)	15 (12 - 17)	33 (30 - 36)	7 (5 - 8)	17 (14 - 19)
Least advantaged	(31)	15 (12 - 18)	29 (25 - 32)	5 (3 - 7)	15 (12 - 18)
Trend		P= 0.090	P= 0.700	P= 0.954	P= <0.001

9.2 Methodological issues

Multiple imputation of individual variables

Data were missing on a number of key variables, including income (35 per cent missing). Complete data on all variables were available for 61 per cent of the sample. Rather than analysing complete cases only, potentially biasing estimates, missing data were imputed under a missing-at-random, assumption where missing values were modelled as a function of observed variables (Klebanoff & Cole 2008). Twenty datasets with imputed values for missing items on each variable were estimated using the imputation by chained equations (ICE) command in Stata 11.1. Analysis was undertaken in Stata 11.1 using the GLLAMM function, prefixed by the user-written 'mim' command (created by JC Galati, P Royston and JB Carlin), which allowed for analysis to be undertaken across multiple datasets.

Multiple imputations of price of basket of alcohol in stores

Prices for missing items were also imputed, as described earlier. We might investigate multi-item response methods to assign values for stores in future analyses. However, further discussion of this method is beyond the scope of this report.

Spatial autocorrelation

Many of the CCD were close geographically, so that in some situations, the individual network buffers used to measure access overlapped for individuals in nearby CCD. This raises the possibility of spatial autocorrelation that might not be accounted for in our current modelling approach. We identified where overlap was possible finding 10 clusters of between two and six CCD; however, models fitted with these CCD clusters as a random effect produced almost identical results.

Residual confounding by area (fixed effects)

Finally, there is potential for residual confounding due to unmeasured area-level characteristics. To verify our findings, we ran models with CCD fitted as fixed effects. The estimates obtained from these models were closer to the null, than for the random-effects models, but the direction of the effect remained the same (data not shown). Fixed-effects models will eliminate confounding, due to area effects, but reduces power, and might also result in over adjustment for area-level mediators of the associations between alcohol density and proximity and risk of alcohol-related harm. Thus, the true estimate is likely to lie somewhere between the random- and fixed-effects models.



Victorian Health Promotion Foundation
PO Box 154 Carlton South, VIC 3053 Australia
T +61 3 9667 1333 F +61 3 9667 1375
vichealth@vichealth.vic.gov.au
www.vichealth.vic.gov.au

December 2011

