Liquor landscapes: Does access to alcohol outlets influence alcohol consumption in young adults?

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Abstract

Few longitudinal studies have examined the impact of liquor licences on alcohol consumption, and none in young adults, the life stage when alcohol intake is at its highest. We examined associations between liquor licences (i.e., general licences, on-premise licences, liquor stores, and club licences) and alcohol consumption at 20-years (n=988) and 22-years (n=893), and whether changes in the licences between time-points influenced alcohol consumption (n=665). Only general licences were associated with alcohol consumption at 20-years ($p=0.037$), but by 22-years, all licences types were positively associated with alcohol consumption ($p<0.05$). Longitudinal analyses showed that for each increase in liquor stores over time, alcohol consumption increased by 1.22 grams/day or 8% ($p=0.030$) and for each additional club licence, consumption increased by 0.90 grams/day or 6% ($p=0.007$). Limiting liquor licences could contribute to a reduction in young adults' alcohol intake.

Key words: Alcohol, Neighbourhood, Alcohol outlet density, Longitudinal, Licence types, Young adults

Introduction

Alcohol use is endemic in many countries, with widespread health, community and economic consequences (Australian Institute of Health and Welfare, 2014, NHMRC, 2009, Collins and Lapsley, 2008, World Health Organization, 2014). Global alcohol consumption in 2010 was estimated at 6.3 litres of pure alcohol per person per annum, and in 2012 some 3.3 million deaths were attributed to alcohol use (World Health Organization, 2014). The highest levels of alcohol consumption occur in developed countries (World Health Organization, 2014). For example, in Australia, total alcohol consumption per capita for drinkers is estimated at 19.7 litres of pure alcohol for males and 9.0 litres for females (World Health Organization, 2014), and 20% of Australians drink at levels that place them at risk of harm over their lifetime (Australian Institute of Health and Welfare, 2014). Alcohol use is particularly pervasive among adolescents and young people, with an Australian national survey reporting that 24% of people aged 15 to 24 engaged in drinking sessions that risked alcohol-related injury at least once a week (Australian Institute of Health and Welfare, 2014). Indeed, adolescents and young adults in Australia are more likely than other age groups to drink at risky levels (Australian Institute of Health and Welfare, 2014).

One of the factors implicated in the pervasive consumption of alcohol is its widespread availability. A growing body of evidence indicates that alcohol outlet density is associated with community-level alcohol consumption and harms, including violent crime, domestic violence, traffic injury and child maltreatment (Bryden et al., 2012, Popova et al., 2009, Gmel et al., 2015, Campbell et al., 2009, Livingston, 2011a, Livingston, 2011b). Studies also show that alcohol outlet density has implications for individual-level alcohol consumption (Livingston et al., 2008, Kavanagh et al., 2011, Pereira et al., 2013, Connor et al., 2011, Kypri et al., 2008). For example, a study of West Australian adults found that for each additional liquor store present in the neighbourhood (i.e., within 1.6 km of home), the mean number of standard drinks of alcohol consumed/drinking day increased by 1% and the mean number of days of harmful alcohol consumption increased by 6% (Pereira et al., 2013). Other studies suggest that the type of outlet matters, and that licences where people can purchase packaged alcohol (typically referred to as off-licence or off-premise outlets) are particularly problematic. For instance, a New Zealand study identified an association between off-premise outlet density within 1 km of home and binge drinking, but found no association for overall outlet density (Connor et al., 2011). Similarly, another New Zealand study of university students found that the effect sizes

for the associations between liquor licences and increased alcohol consumption and alcohol-related problems were consistently larger for off-premise outlets than on-premise venues (Kypri et al., 2008).

Despite considerable cross-sectional evidence, few longitudinal studies have tested whether there is a relationship between alcohol outlet density and adults' individual-level alcohol consumption (Bryden et al., 2012, Gmel et al., 2015). Three studies have examined associations between the density of, or proximity to, *on-premise* venues (e.g., bars, nightclubs, taverns) (Picone et al., 2010, Brenner et al., 2015, Halonen et al., 2013), but just one identified a significant relationship. For a sample of Finnish adults (mean age=44.2 years), decreasing the distance to the nearest on-premise venue was associated with increases in heavy alcohol use (Halonen et al., 2013). In contrast, two studies have examined the relationship between *off-premise* licences (e.g., liquor stores) and alcohol consumption, and both identified significant effects (Brenner et al., 2015, Cooper et al., 2013). Brenner et al. (2016) found that increasing off-premise licence density within 1 mile from home was associated with increased alcohol consumption among older adults (mean baseline age=61.9 years), and Cooper et al. (2013) found that a reduction in outlet density/square mile equated to reduced odds of binge drinking among public housing tenants who relocated (mean baseline age=43.1 years). On balance, these longitudinal studies suggest that off-premise outlets, rather than on-premise licenced venues, may have a greater impact on alcohol consumption, however few longitudinal studies have tested the role of different licence types. Moreover, these longitudinal studies focus on mid-age and older populations, and there is a paucity of studies relating to younger adults.

Strategies to curb the widespread community availability of alcohol are advocated to help minimise alcohol consumption and harms (Kypri et al., 2008, Brenner et al., 2015, Rowland et al., 2016, Badland et al., 2015). Indeed, a decade ago, Stockwell and Gruenewald (2004, p.225) concluded that on balance, studies 'strongly suggest that limits on outlet density may be an effective means of controlling alcohol problems and need to be taken more seriously as an effective policy tool for the reduction of alcohol-related harm' (Stockwell and Gruenewald, 2004). Yet others are hesitant to advocate for policy interventions to reduce outlets without a stronger, more consistent body of evidence, including evidence on different licence types (Gmel et al., 2015). Thus, this study seeks to provide a finer grain understanding of the influence of different liquor licences on alcohol consumption at a life-stage when alcohol use is at its highest (Australian Institute of Health and Welfare, 2014). We tested the cross-sectional and

longitudinal associations between four liquor licences categories in the home neighbourhood (i.e., general licences, liquor stores, on-premise venues and club licences) and alcohol consumption in young adults in Perth, Western Australia.

Our overall hypothesis was that there would be a stronger relationship between off-premise licences and alcohol consumption than on-premise licences. Packaged licences sell larger volumes of alcohol for consumption in uncontrolled environments, whereas on-premise drinking is, to some extent, regulated by venue management or social norms about acceptable levels of alcohol consumption (Piontek et al., 2013, Stockwell et al., 1993, Sandiford and Divers, 2014). We also examined whether associations differed by gender (all analyses), as females are more likely to abstain from alcohol use, typically consume less alcohol than males, and are less likely to drink at harmful levels (Babor et al., 2010). Furthermore, we tested for differences by whether participants moved house (longitudinal analyses only), as respondents who prefer to consume alcohol may self-select into neighbourhoods that support this behaviour (i.e., with more liquor licences). Non-significant differences between stayers and movers would provide stronger support for the hypothesis that changes in neighbourhood liquor licences impact on alcohol consumption.

Methods

Participants were drawn from the Western Australian Pregnancy Cohort (Raine) Study, a prospective cohort study that has followed participants from gestation to early adulthood. The Raine Study is described in detail elsewhere (Newnham et al., 1993). Briefly, 2,900 pregnant women at 16–20 weeks gestation were recruited between 1989 and 1991 through the public antenatal clinic and local private clinics in Perth, Western Australia. Of these, 2,804 women (97%) delivered live birth babies. Due to multiple births, the initial cohort included 2,868 infants. These children and their families have since been followed at regular intervals. Informed consent was obtained from mothers from enrolment until child participants were aged 18-years. Assent was obtained from the participants at age 14 and 17-years, and informed consent obtained at 20 and 22-years. The Raine study protocol was approved by the ethics committees of King Edward Memorial Hospital for Women and Princess Margaret Hospital for Children, Perth, Western Australia. Ethical approval for the 20 and 22-year follow-ups was obtained from the University of Western

Australia Human Research Ethics Committee (RA/4/1/2646 & RA/4/1/5202). This study focuses on participants who provided alcohol consumption data and lived in the Perth metropolitan area between 2009-2011 (20-year follow-up) and 2012-2014 (22-year follow-up).

Outcome - Alcohol consumption: The self-administered Anti-Cancer Council of Victoria Food Frequency Questionnaire (ACCVFFQ) was used to collect alcohol consumption data at 20 and 22-years (note: the legal drinking age in Australia is 18). The ACCVFFQ has been previously used in large epidemiological studies and compares well with other validated measures (Hodge et al., 2000). Participants were asked how often they drank low strength beer, full strength beer, red wine, white wine (including sparkling), fortified wines, and spirits/liqueurs over the last 12 months. Response options were: never; less than once a month; 1-3 days per month; 1 day per week; 2 days per week; 3 days per week; 4 days per week; 5 days per week; 6 days per week and every day. Participants were also asked the amount that they usually consumed on days that they drank (total number of glasses) and the maximum number of glasses that they drank in a 24 hour period. All these items were converted into a total alcohol consumption variable (grams of ethanol/day). For reference, one standard drink contains 10 grams of ethanol (NHMRC, 2009). Maximum glasses drank in a 24 hour period was also examined separately as a measure of risky/binge drinking.

Independent variables – liquor licences: Participants' home addresses at each time-point were geo-coded in Geographic Information Systems (GIS) (ArcGIS v10.2.2, ESRI). Licence locations that temporally matched the 20 and 22-year follow-ups were sourced from the Western Australian Department of Racing, Gaming and Liquor (DRGL) (i.e., 20-year sample matched with 2011 data; 22-year sample matched with 2014 data). All liquor licence locations were mapped in GIS and counts within a 1600m road network distance of each participant's address computed. This equates to the maximum distance participants' could briskly walk in about 15 minutes (Foster et al., 2014). Four licence types were examined: (1) general licences (i.e., on-premise consumption and take away sales, such as unrestricted hotels and taverns); (2) liquor stores (i.e., packaged liquor sales only); (3) on-premise venues (i.e., consumption at the venue only, such as restricted hotels and taverns, nightclubs, restaurants and small bars); and (4) club licences (i.e., sporting and social clubs that allow members and guests to consume alcohol at the club, and restricted club licences that allow the sale of packaged liquor to members).

Adjustment variables: Socio-demographic variables included sex, highest education level at 20 and 22-years (secondary or less; TAFE/college; university), family income at 17-years (less than \$25,000; \$25,000-\$50,000; \$50,000-\$78,000; \$78,000 or more; not reported - income was only available at 17-years), area disadvantage at 20 and 22-years based on the Australian Bureau of Statistics (ABS) Index of Relative Socioeconomic Disadvantage (IRSD), and moving house between 20 and 22-years (i.e., 'stayers' versus 'movers'). Self-report mental health was assessed using the depression, anxiety, and stress scales from the short form DASS-21 (Lovibond and Lovibond, 1995), which has been validated in clinical and nonclinical samples (Antony et al., 1998, Henry and Crawford, 2005).

Statistical analysis

Descriptive statistics were computed for each variable at each time-point. Change variables (follow-up minus baseline values) were created for all time-varying variables (i.e., licences, alcohol consumption, education, area disadvantage, depression, anxiety and stress) between 20 and 22-years. We conducted cross-sectional and longitudinal (within person) analyses so that the cross-sectional results can be compared to previous cross-sectional findings and to our own longitudinal (within person) findings. Individual linear regression models were used to examine cross-sectional associations between the count of licences (i.e., the independent variables) and alcohol consumption at 20 (n=987) and 22-years (n=893), controlling for sex, age, education, family income, area disadvantage, depression, anxiety and stress (see Supplementary Table 1 for a full model with all estimates presented). Longitudinal (within person) analyses examined whether the change in the number of licences between 20 and 22-years was associated with a change in alcohol consumption between 20 and 22-years (n=665). These models controlled for family income (at 17-years), sex, education, area disadvantage, depression, anxiety and stress, and alcohol consumption (all at 20-years), change in area disadvantage, education, depression, anxiety and stress between 20 and 22-years, and whether participants moved house between time-points. When there are only two time-points with longitudinal data, analysis of the change variable is equivalent to a fixed effects longitudinal repeated measures analysis that isolates the within-person effect (Fitzmaurice et al., 2011). Interactions between licence types and gender were examined cross-sectionally and longitudinally, and models were run for the combined and gender stratified samples. For the longitudinal analyses, we also tested for interactions between licence types and moving house between time-points (i.e., 'movers' versus 'stayers'). All analyses were conducted in SPSS version 22.

Results

The sample characteristics at 20 and 22-years (i.e., cross-sectional samples) and changes between 20 and 22-years (i.e., longitudinal sample) are presented in Table 1. The average total alcohol intake at 20-years was 16.0 grams of ethanol/day and 15.6 grams/day at 22-years (i.e., equating to approximately 11 standard drinks/week at both time-points). The maximum glasses consumed in 24 hours was also similar at 20 and 22 years (i.e., 9.4 versus 9.8 glasses). Alcohol intake was higher for males (i.e., 19.2 grams/day or 13 standard drinks/week at 20-years; 20.2 grams/day or 14 standard drinks/week at 22-years) than females (i.e., 13.3 grams/day or 9 standard drinks/week at 20-years; 11.5 grams/day or 8 standard drinks/week at 22-years) at both time-points (results not shown). When the sample was restricted to those in the longitudinal analysis (n=665), there was a small increase in alcohol consumption between 20 and 22-years (i.e., 0.11 grams/day). Most participants (71.6%) remained in the same house between time-points ('stayers') and 28.4% moved house ('movers'). Stayers had a slight reduction in alcohol consumption between 20 and 22-years, whereas movers had a slight increase in alcohol consumption (differences were non-significant).

At 20-years, mean counts of liquor licences were 1.0 general licences, 3.6 on-premise venues, 1.5 liquor stores and 2.0 club licences within 1600m neighbourhood. Analysis of the longitudinal sample (n=665) indicated there were significant increases in the number of on-premise venues, liquor stores and clubs in participants neighbourhoods between 20 and 22-years. However, when stayers and movers were compared, there were no significant differences in the change in licences between 20 and 22-years.

[Insert Table 1 about here]

Table 2 presents the cross-sectional findings at 20-years. General licences were positively associated with higher levels of alcohol consumption after adjustment for confounders ($p=0.037$). Each additional general licence was associated with an average increase of 0.6 grams of ethanol/day, which equates to less than half a standard drink/week. All interaction terms for licences and gender were non-significant, however the stratified analysis suggests an association between general licences and alcohol consumption in males, but not females. There were no significant associations between liquor licences and risky/binge drinking (results not shown).

[Insert Table 2 about here]

Table 3 presents the cross-sectional findings at 22-years. At this time-point, the number of general licences, on-premise venues, liquor stores and clubs licences were all positively associated with alcohol consumption (all $p < 0.05$). For example, each additional liquor store was associated with an average increase of 0.9 grams of ethanol/day (i.e., just over half a standard drink/week). All interaction terms for licences and gender were non-significant, however the gender stratified results suggested there was stronger evidence of an association between licences and alcohol consumption for females than males. The associations between liquor licences and risky/binge drinking were similar to those for alcohol intake/day, with on-premise venues, liquor stores and club licences all positively associated with higher levels of consumption within 24 hours (all $p < 0.05$) (results not shown).

[Insert Table 3 about here]

Table 4 presents the longitudinal results for the change in liquor licences and alcohol consumption between 20 and 22-years. There were positive associations between access to liquor stores and club licences and alcohol consumption, where for each additional liquor store, alcohol consumption increased by 1.22 grams/day between 20 and 22-years ($p = 0.030$), and for each additional club licence, alcohol consumption increased by 0.90 grams/day between 20 and 22-years ($p = 0.007$). These increases equate to approximately 0.8 and 0.6 standard drinks/week, respectively. Again, all interaction terms for licences and gender were non-significant (i.e., some approached $p = 0.10$), however the gender stratified results indicated more support for an association between licences and alcohol consumption among females than males. Additional analyses of the change in liquor licences and change in maximum glasses consumed in 24 hours showed positive associations for general licences, liquor stores, club licences (all $p < 0.05$). Finally, although movers had an overall greater change in alcohol consumption than stayers (i.e., main effect, results not shown), the effect of change in liquor licences on change in alcohol consumption was not significantly different in movers and stayers (i.e., non-significant interaction terms).

[Insert Table 4 about here]

Discussion

This study found cross-sectional evidence suggesting the number and type of liquor licences in the home neighbourhood was associated with alcohol consumption at both 20 and 22-years. General licences (i.e., that allow on-premise consumption and packaged liquor sales) were positively associated with consumption at 20-years, however by 22-years, all licence types were associated with alcohol consumption. Furthermore, longitudinal analyses found evidence in support of a *potentially* causal relationship, whereby increases in liquor stores and club licences between 20 and 22-years were associated with increased alcohol consumption. Findings for our measure of risky/binge drinking were generally consistent with those for overall average alcohol consumption.

Few studies have examined the longitudinal relationship between alcohol licences and individual-level alcohol consumption, but the consensus from the studies to date is that liquor store density (Cooper et al., 2013, Brenner et al., 2015) and proximity to bars (Halonen et al., 2013, Picone et al., 2010) can impact on residents' drinking patterns. In our study of young adults, we found a longitudinal association between liquor stores and alcohol consumption, but not on-premise licences. This is consistent with a large US study of older adults that found an increase in liquor store density per square mile was associated with a 7% and 11% increase in weekly alcohol consumption for men and women respectively, but found no association for on-premise venues. Notably, each study of liquor stores and alcohol consumption has focused on a different age group: Brenner et al. (Brenner et al., 2015) examined older adults, Cooper et al. (Cooper et al., 2013) examined mid-age adults, and we examined young adults, suggesting liquor store density may influence alcohol consumption in the resident population, regardless of age.

The presence of more liquor stores reduces the real cost of alcohol, with increased availability reducing the monetary price and increasing the convenience of purchase (Livingston, 2011b), and can contribute to a greater acceptance of alcohol and normalising of alcohol consumption among local residents (Gruenewald, 2007). Our longitudinal results show that each increase of one liquor store between 20 and 22-years was associated with an average increase of 1.22 grams/day ethanol (i.e., increases consumption on average by 8%). Liquor stores offer cheaper alcohol than on-premise venues, which may be particularly relevant to this age group who have less disposable income and may be more price sensitive. In Australia, packaged liquor sales account for about 80% of all alcohol consumed (Howard et al., 2014), and this is most commonly consumed in the home, either with a meal, at a celebration, or before or after going out to another licenced premise such as a pub or nightclub (i.e., in settings with

few restrictions on consumption) (Victorian Health Promotion Foundation, 2013). Indeed, pre-loading has been identified as a growing phenomenon among young people, whereby alcohol is purchased and consumed prior to going to venues where drinks are known to be expensive (Adrian and Kerry, 2014, Foster and Ferguson, 2014). This trend would suggest that the availability of alcohol in close proximity to home may be of increasing concern in relation to young people.

We also found that each increase of one club licence between 20 and 22-years was associated with an increase of 0.90 grams/day ethanol (i.e., increases consumption on average by 6%). Similar to liquor stores, club licences also provide comparatively cheap alcohol in a setting where there are potentially with less stringent controls over consumption (Kingsland et al., 2013). In particular, community sports clubs have been linked with higher levels of alcohol consumption and risky drinking (Poortinga, 2007, Rowland et al., 2012), which stems from a culture that promotes drinking (e.g., as a reward for good performance) and the clubs' alcohol management practices (e.g., alcohol promotions, the need to generate club revenue from bar sales, opening hours, happy hour discounts) (Rowland et al., 2012, Kingsland et al., 2013, Munro, 2000). Some 26% of Australians over 15 years of age are involved in organised sport (ABS, 2010), making clubs an important health promotion setting to target drinking patterns in young adults. Indeed, there is evidence that programs that promote the responsible service of alcohol (e.g., the 'Good Sports' alcohol management program) can limit hazardous alcohol consumption by club members (Rowland et al., 2012, Rowland et al., 2015).

Our longitudinal sample comprised both stayers and movers, and different processes impacted their exposure to liquor licences. For stayers, the environment changed due to new licence approvals, whereas for movers, their environment changed because of their change of address. It's plausible that between the age of 20 and 22, young adults would relocate more vibrant 'liveable' areas, with better access to shops, services, education, employment, recreation and transit (Myers, 2016), and paired with this greater access to liquor licences, but this was not apparent from our data. Indeed, stayers experienced greater increases in liquor licences than movers. Despite this, all interactions between liquor licences and stayers/movers were non-significant, indicating that the findings were not influenced by participants remaining in place or self-selecting into neighbourhoods that might support a preference for drinking.

The largest effect size we identified was for the longitudinal association between liquor stores and alcohol consumption, where every additional liquor store was associated with an 8% increase in alcohol consumption for each additional store. When considered in context with the myriad of other individual, social and cultural factors that influence alcohol consumption (e.g., age, gender, cultural background, living situation, parental alcohol use, relationships with parents, disruption to family structure and social networks, parental educational attainment, peer alcohol use, impulsiveness and so on) (Livingston et al., 2008, Galea et al., 2004, Substance Abuse and Mental Health Services Administration (SAMHSA), 2015), it is unsurprising that more distal environmental factors have a relatively modest impact on behaviour. However, as a contextual environmental factor, an 8% increase in alcohol consumption per liquor store is substantial enough to suggest that interventions designed to limit neighbourhood liquor stores could impact residents' alcohol consumption levels.

This study has a number of strengths. The longitudinal Raine sample provided a rare opportunity to study changes in alcohol access and changes in alcohol intake, given that experimental trials are unfeasible. To our knowledge this is the first longitudinal study to test the impact of individual-level changes in access to different liquor licence types and alcohol consumption in young adults. Objective measures of alcohol access were created for each participant's own 'ego-centric' neighbourhood, and using DRGL data (i.e., more comprehensive licencing information than provided by commercial databases), and licence data temporally matched each Raine survey data collection. Analyses also adjusted for individual-level characteristics (e.g., demographics, family income and mental health) and area-level socio-economic disadvantage, and tested differences for gender and neighbourhood relocation. Importantly, our longitudinal analyses presents a purely longitudinal effect, whereby each individual acts as their own control for time constant selection factors and confounders (Knuiman et al., 2014). For instance, if a person has a propensity to consume alcohol at high levels and that propensity was the same at both time points, then it has been controlled in the analyses. However, it should also be noted that there may be other (unmeasured) intra-person factors that changed over time and might confound our longitudinal findings.

There were no substantive policy or zoning changes during the study time-frame that would impact our findings.

The most notable recent amendment to liquor licencing policy in Perth was the introduction of small bar licences in

2007, which was intended to encourage a 'more mature drinking culture' (Drug and Alcohol Office, 2013). The policy was introduced prior to our first time-point (i.e., 20 years, data collection 2009-2011) and resulted in over 100 small bars in the decade since – predominantly located in the city and main entertainment district (Macdonald, 2016). In our study, small bars were included in on-premise licences, which were associated with alcohol consumption at 22 years, but not linked to changes in consumption between 20-22 years. The increase in small bars between 20 and 22 years may have increased the number of on-premise licences for some participants, and contributed to a greater change in licences, but ultimately these licence types did not influence alcohol intake.

This study also has limitations. First, we do not have information on whether participants purchased and consumed alcohol locally. However, it is plausible that the impact of the home neighbourhood may be compounded for this generation, as 'millennials' (i.e., those born from the early 1980s to the early 2000s) in developed countries are now less likely to acquire a driver's licence (Delbosc and Currie, 2013) and evidence from the US indicates this has not been offset by an increase in sustainable travel modes (McDonald, 2015). Furthermore, Perth is a largely suburban, car dependent city, with many areas poorly serviced by public transport (Newman and Kenworthy, 1999), and this combination may amplify the association between the home neighbourhood and health behaviours. Nonetheless, we cannot discount the possibility that this combination (i.e., suburban, car dependent, poor public transport) means young adults drive outside their local area to purchase and drink alcohol. Second, we focused on the 1600m road network distance, however arbitrarily defined neighbourhoods may bear little resemblance to what a person perceives their neighbourhood to be (Chaix et al., 2009, Smith et al., 2010), and our neighbourhood measure does not capture an individual's broader exposure to alcohol licences (Holmes et al., 2014). Finally, our self-reported alcohol consumption measure is likely to underestimate the amount of alcohol consumed (Stockwell and Gruenewald, 2004), however any underreporting would bias the cross-sectional findings to the null, and if an individual's reporting bias is in the same direction at both time-points, it would have minimal impact on the longitudinal results.

Conclusion

This study adds to the small number of longitudinal studies that indicate a potentially causal relationship between off-premise licences and alcohol consumption in adult populations (Brenner et al., 2015, Cooper et al., 2013). In

addition, we found evidence that club licences also had an influence on alcohol intake in young adults. While the effect sizes identified were relatively modest, the number of liquor licences in the local community is one of the few influences on alcohol consumption that could be readily targeted by interventions to the built environment, whereas most individual, social and cultural factors cannot be changed, or are difficult to change. Our results suggest that policies designed to limit the number of neighbourhood liquor licences could contribute to a reduction in young adults' alcohol consumption levels, during this life stage when alcohol consumption is at its highest.

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Results

Table 1 Sample characteristics at 20 and 22-years, and changes between 20 and 22-years.

	Cross-sectional sample		Longitudinal sample: Δ 20-22 years ^a				
	20-years (n=988)	22-years (n=893)	Full sample (n=665)		Stayers (n=476)	Movers (n=189)	
	Mean (SD) Range	Mean (SD) Range	Mean (SD) Range	p ^c	Mean (SD) Range	Mean (SD) Range	p ^d
Age	20.0 (0.4) 18.5-22.0	22.1 (0.6) 20.5-24.5	2.1(0.5) 0.4-4.0		2.1 (0.5) 0.4-3.9	2.1 (0.5) 0.6-4.0	0.125
Sex (male) ^b	47.4	47.4	-		48.2	43.5	0.265 ^e
Education ^b							
Secondary or less	73.3	49.7	Same: 69.8		Same: 68.3	Same: 73.3	0.208 ^e
TAFE/college/other	20.4	24.2	Higher: 30.2		Higher: 31.7	Higher: 26.7	
University	6.4	26.2					
Parent income at 17 ^b							
Not reported	23.9	22.8					
Less than \$25,000	4.9	4.8					
\$25,000 - \$50,000	13.6	12.7					
\$50,000 - \$78,000	15.2	15.5					
\$78,000 or more	42.5	44.2					
Area disadvantage decile	6.4 (2.9) 1-10.0	6.5 (2.8) 1-10.0	Lower: 12.9 Same: 75.7 Higher: 11.4		Lower: 0.0 Same: 100.0 Higher: 0.0	Lower: 45.0 Same: 14.2 Higher: 39.8	0.000 ^e
Alcohol intake (g/day)	16.0 (18.2) 0-104.4	15.6 (17.9) 0-97.8	0.1 (15.9) -70.2-79.4	0.854	-0.4 (16.5) -70.2-79.4	1.3 (14.5) -56.6-65.0	0.214
Max. drinks in 24 hrs	9.4 (6.0) 0-19.0	9.8 (5.8) 0-19.0	0.3 (5.0) -18.0-19.0	0.080	0.4 (5.1) -18.0-19.0	0.2 (4.5) -14.0-10.0	0.554
Depression	7.0 (7.9) 0-42.0	6.8 (8.1) 0-42.0	-0.1 (7.1) -32.0-24.0	0.702	-0.5 (6.6) -32.0-24.0	0.9 (8.1) -28.0-24.0	0.037
Anxiety	5.6 (5.8) 0-38.0	5.2 (5.5) 0-32.0	-0.4 (5.3) -24.0-20.0	0.052	-0.4 (5.2) -24.0-20.0	-0.3 (5.4) -22.0-14.0	0.876
Stress	8.6 (8.0) 0-42.0	8.7 (8.1) 0-42.0	0.3 (7.1) -26.0-30.0	0.284	-0.2 (7.1) -26.0-24.0	1.4 (7.2) -18.0-30.0	0.010
Licence types (counts)							
General licences	1.0 (2.0) 0-25.0	1.0 (1.7) 0-49.0	-0.0 (1.7) -18.0-11.0	0.684	0.0 (0.3) -1.0-1.0	-0.1 (3.2) -18.0-11.0	0.548
On-premise venues	3.6 (7.5) 0-80.0	4.2 (8.2) 0-159.0	0.6 (7.1) -80.0-57.0	0.047	0.8 (1.9) -1.0-19.0	-0.0 (12.9) -80.0-57.0	0.383
Liquor stores	1.5 (1.4) 0-8.0	1.6 (1.5) 0-8.0	0.1 (1.0) -6.0-5.0	0.015	0.1 (0.4) -1.0-3.0	0.0 (1.7) -6.0-5.0	0.502
Clubs	2.0 (2.3) 0-14.0	2.2 (2.4) 0-13.0	0.2 (1.6) -11.0-10.0	0.000	0.2 (0.7) -1.0-4.0	0.2 (2.8) -11.0-10.0	0.818

^a Change values calculated by subtracting baseline values from follow-up values

^b Values expressed as a percentage

^c P value from paired t-tests comparing variables at 20 and 22-years (i.e., using the longitudinal subset n=665)

^d P value from t-tests comparing change in stayers and movers (i.e., using the longitudinal subset n=665)

^e P value from Pearson Chi-square test comparing change in stayers and movers (i.e., using the longitudinal subset n=665)

Lower: Variable decreased between 20 and 22 years; Same: Variable was the same at 20 and 22 years; Higher: variable increased between 20 and 22 years.

Table 2 Linear regression models of the association between the liquor licence types within **1600m** of home and average **daily alcohol consumption** (g/day) at 20-years

Licence types (counts)	Males (n=471)		Females (n=517)		Both (n=988)	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
General licences	1.435	0.012	0.224	0.443	0.602	0.037
On-premise venues	0.221	0.100	0.088	0.291	0.145	0.058
Liquor stores	0.277	0.696	0.422	0.337	0.304	0.448
Clubs	0.519	0.230	0.537	0.063	0.482	0.059

Adjusted for education, family income at 17 years, area disadvantage, depression, anxiety and stress; combined analysis also adjusts for sex; bold denotes $p < 0.05$.

Table 3 Linear regression models of the association between the liquor licence types within **1600m** of home and average **daily alcohol consumption** (g/day) at 22-years

Licence types (counts)	Males (n=424)		Females (n=469)		Both (n=893)	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
General licences	0.850	0.187	1.062	0.003	0.950	0.009
On-premise venues	0.126	0.353	0.254	0.000	0.199	0.005
Liquor stores	1.091	0.138	0.838	0.050	0.906	0.024
Clubs	1.208	0.006	0.707	0.009	0.907	0.000

Adjusted for education, family income at 17 years, area disadvantage, depression, anxiety and stress; combined analysis also adjusts for sex; bold denotes $p < 0.05$.

Table 4 Linear regression models of the association between change in liquor licence types within **1600m** of home and change in average **daily alcohol consumption** (g/day) between 20 and 22-years

Licence type (Δ counts)	Males (n=311)		Females (n=354)		Both (n=665)	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
General licences	-0.399	0.670	0.681	0.011	0.542	0.084
On-premise venues	-0.090	0.652	0.131	0.049	0.096	0.203
Liquor stores	0.432	0.710	1.609	0.003	1.222	0.030
Clubs	0.758	0.287	0.862	0.006	0.895	0.007

Adjusted for education, family income at 17 years, area disadvantage, depression, anxiety and stress and daily alcohol consumption (all at 20-years), changes in area disadvantage, education, depression, anxiety and stress between 20 and 22-years and whether participants moved house between 20 and 22-years; combined analysis also adjusts for sex; bold denotes $p < 0.05$.

Supplementary Table 1 Linear regression models of the association between the general licences within **1600m** of home and average **daily alcohol consumption** (g/day) at 20-years.

Variables	Estimate	SE	P-value
General licences	0.602	0.2881	0.037
Depression	-0.025	0.1045	0.811
Anxiety	0.349	0.1528	0.022
Stress	-0.171	0.1218	0.160
Disadvantage decile	0.361	0.2074	0.082
Sex (male)	5.706	1.1735	0.000
Education			
Not reported	22.546	10.5638	0.033
Secondary or less	1.761	2.3741	0.458
TAFE or college	.362	2.6189	0.890
University (ref.)	0		
Family income			
Not reported	1.134	1.4749	0.442
Less than \$25,000	-2.091	2.7550	0.448
\$25,000-\$50,000	-2.216	1.8454	0.230
\$50,000-\$78,000	2.170	1.7254	0.209
\$78,000 or more (ref.)	0		

Bold denotes $p < 0.05$.

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