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Off-site outlets and alcohol-related harm

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List of abbreviations

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
ARIA	Accessibility/Remoteness Index of Australia
ARIA+	Accessibility/Remoteness Index of Australia Plus
DAO	Drug and Alcohol Office (Western Australia)
DRGL	Department of Racing, Gaming and Liquor (Western Australia)
ED	emergency department
ERP	estimated resident population
FIFO	fly-in fly-out
HWSS	Health and Wellbeing Surveillance System (Western Australia)
IPV	intimate partner violence
IRR	incidence rate ratio
LGA	local government area
NASDP	National Alcohol Sales Data Project
NDRI	National Drug Research Institute
OLGR	Office of Liquor and Gaming Regulation (Queensland)
SEIFA	Socio-Economic Indexes for Areas
SLA	statistical local area
WHO	World Health Organization

Definitions

Off-site outlet	An alcohol outlet that sells alcohol for consumption away from the premise (eg bottleshop liquor store)
On-site outlet[1]	An alcohol outlet that sells alcohol primarily for consumption on the premise (eg bar)

1 Some on-site outlets may sell alcohol for consumption both on and off the premise.

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Executive summary

Background

The aim of this study was to investigate the relation between rates of violence, alcohol sales and numbers of outlets in both Queensland (stage one) and Western Australia (stage two), while controlling for a range of potential confounders. The cross-sectional study design will enable investigation of:

- The suitability of applying off-site outlet numbers versus alcohol sales volumes as a measurement tool for modelling and predicting future levels of problems from liquor licensing changes.
- The magnitude of the relation between alcohol sales/numbers of outlets and violence for off-site versus on-site outlets.
- Differentiated effects of off-site versus on-site outlets on levels of violence occurring at private residences versus licensed premises and other types of locations (eg street).

The international and national off-site outlet literature suggests that liquor stores may contribute substantially to alcohol-related harms, especially violence. To establish causality, however, the strongest designs for future research should not only include longitudinal data but also seek to incorporate reliable estimates of alcohol sales and/or consumption into their models. Overall, a shortcoming of the licensed outlet density literature has been its lack of attention to alcohol sales by licensed outlets.

The outlet density and violence literature is dominated by United States research and, with only a few exceptions (Stevenson et al. 1998; Stockwell et al. 1998), largely comprises studies that are restricted to measuring outlet density by counting numbers of outlets and then converting them to a rate (eg per resident, per unit geographical area, per road miles) while excluding measures that quantify alcohol sales made by these outlets. A limitation inherent to count-based models (even in longitudinal studies) is that they cannot account for variation between outlets and their variable capacity to influence alcohol availability in the communities in which they operate (Liang & Chikritzhs 2011).

Alcohol sales data

The Queensland Office of Liquor and Gaming Regulation and the Western Australia Department of Racing, Gaming and Liquor are responsible for administering liquor licensing regulation in Queensland and Western Australia, respectively. Both agencies require the collection of alcohol sales data in their jurisdictions. WA data have been routinely and consistently collected for many years (early 1990s onwards) while the Queensland data collection was restarted several years ago after cessation in 1996 (Loxley et al. 2009). Both systems require wholesalers to report their sales to retailers on an annual basis; however, it is a unique feature of the Queensland licensing system that to hold an off-site liquor store licence (ie bottleshop), a licensee must first possess a hotel licence. Under this system, a hotel licensee may be granted up to three detached liquor stores that are linked to, but geographically distinct from, the one primary hotel licence. Usually, the detached bottleshop(s) must also be located within a 10 kilometre radius of the primary hotel. No similar requirements are made of WA licensees.

Methods

Reported assaults for 2008–09 were obtained from Queensland and WA police services. The data provided enabled aggregation of assaults into local government areas (LGAs) based on the place of occurrence. Information pertaining to location of offence, type of offence, time of day/day of week of occurrence, and age/

sex of victims was also obtained. Authorities in Queensland and Western Australia provided data on licensed premises in each state including address and licence type (eg hotel, restaurant, bottleshop), which enabled grouping by LGA.

Alcohol sales data were also provided for both states although there were some functional limitations in relation to the Queensland sales data. Due to the Queensland licensing requirement that off-site outlet holders also possess a primary hotel licence, liquor returns made by Queensland wholesalers usually combined sales data for all outlets held under the primary hotel licence. It was not possible therefore to distinguish alcohol sales made by hotels from those made by bottleshops in Queensland. This restricted the use of Queensland sales data to overall totals by LGA, and precluded statistical models from distinguishing alcohol sales by type of outlet. For Western Australia, no such limitations applied and average sales made by on-site and off-site outlets could be estimated.

Counts of violent assault offences formed the dependent variable in all analyses. In Queensland, the key explanatory variables of interest were counts of outlets by major outlet types (bottleshops, hotels/nightclubs, restaurants, social clubs, other) and level of total pure alcohol sales. For Western Australia, key explanatory variables included on-site and off-site outlet counts and on-site and off-site outlet alcohol sales. All models included a full complement of potential demographic and socioeconomic confounders, including—estimated residential population aged 15 years or older, mean age of males, mean age of females, proportion of males aged 15 years or older, population density, socioeconomic index, Indigenous residents, substantial mining activity, remoteness, and tourism activity. LGAs with current alcohol restrictions (ie liquor bans) were excluded from analyses.

For each state, five individual models were created in relation to the type of location where the assault occurred—total assaults, assaults at on-site outlets, assaults at residential premises, assaults in the street, and assaults at 'other' places. Models were also created for assault by time of day and for specific subpopulations of interest based on age and gender details provided on the victim. Multivariate negative binomial regression was the statistical test of choice.

It is important to note in relation to the analyses applied to WA data that there are several differences between the approach taken in this study and that taken by the Liang and Chikritzhs (2011) study that preclude the precise comparison of estimated risks. The current study offers a substantial improvement on the Liang and Chikritzhs (2011) approach. It includes several control variables that were not taken into account in the earlier WA work, including the presence of alcohol restrictions, mining activity and tourism activity. The results demonstrate that these are important variables and that including them enhances the accuracy of the models. Moreover, the current WA models used an arguably improved measure of off-site and on-site outlet sales volume. The Liang and Chikritzhs (2011) approach to measuring volume took account of the estimated resident population (ERP) by including it as a potential confounder in the models but did not include adult population in the rate. The current model specifies population (per adult aged 15 years or older) in the rate in addition to controlling for ERP in the model. This is arguably a more robust approach to representing risk as it takes better account of population size variability across regions.

Results

- Significant positive associations were found between numbers of hotels/nightclubs and assaults reported for Queensland (ie as numbers of hotels increased, risk of assault increased). An association was also apparent for restaurants and risk of assault, although the size of the effect was small.
- No effect specific to counts of bottleshops was found in any of the Queensland models. As described above, alcohol sales specific to bottleshops could not be identified and applied in the models due to the manner in which Queensland wholesalers reported sales to hotels and their linked bottleshops. The noted limitation that counts of bottleshops but not bottleshop alcohol sales could be applied in the Queensland models may partly explain the lack of findings for bottleshops.

- Although it was not possible to control for alcohol sales specific to bottleshops in the models, total volume of alcohol sales in an LGA could be controlled for and it significantly predicted the risk of violence in Queensland. Higher levels of total alcohol sales in Queensland LGAs significantly predicted greater risk of assaults occurring at on-site outlets, assaults in the street, serious assaults and those occurring against female victims.
- There were very strong linear associations between Indigenous status and assault among the Queensland data, and the association appears to have been stronger and more consistent than liquor outlet count or alcohol sales effects.
- Queensland LGAs with substantial mining activity had lower risk of reported assault than elsewhere. It is possible that this may be partly due to systematic under-reporting of violent incidents to police in these areas but this requires further investigation.
- Compared with LGAs with the lowest levels of total alcohol sales, Queensland LGAs with higher levels of sales indicated lower risk of sexual assault; however, it is unclear why this might be and the finding warrants further investigation.
- Among the Queensland data, businesses with liquor licence types categorised as 'other' (eg motels, movie theatres, florists) indicated a small protective effect (less than 1%) on assaults occurring among children, young people and young males, and with lower risk for common assaults and day-time assaults. Less than 50 percent of these premises were indicated as having purchased alcohol from a wholesaler in 2008–09.
- Among the WA data, off-site alcohol sales (bottleshops) predicted total assaults and all other dependent assault variables tested with the exception of murder/manslaughter and assaults occurring at on-site outlets.
- The association between off-site alcohol sales and reported assault in Western Australia was largest when assaults reportedly occurred in the street.
- Numbers of WA on-site outlets significantly predicted assaults in most models tested including total assaults.
- Numbers of WA off-site outlets and alcohol sales from on-site outlets showed no significant effects in any of the models tested.
- An unexpected protective effect for WA on-site outlet sales on assaults occurring among people aged 15–30 years was indicated but was not significant when examined among young males specifically.
- For Western Australia, when assaults occurring specifically at hotels/taverns were selected, the number of on-site outlets was a significant predictor and the risk for off-site outlet alcohol sales approached significance. When assaults specific to restaurant locations were examined, both numbers of on-site outlets and numbers of off-site outlets were found to be significant predictors.
- The presence of substantial mining activity in WA LGAs predicted higher levels of reported violence in several models including total assaults.
- With the exception of murder/manslaughter and assaults that occurred at on-site outlets, all models tested indicated that LGAs with higher proportions of Indigenous residents had higher risk of assault reported to police compared with LGAs with low proportions of Indigenous residents.

Conclusions and recommendations

For the foreseeable future, there is likely to be a growing trend towards the application of public interest tests that consider harm, ill health or public amenity effects of a liquor application by liquor licensing decision makers. This may lead to a more purposeful reliance on objective local data to assist in evidence-based decision making.

For the first time, this study has demonstrated significant associations between numbers of assaults reported to police and numbers of hotels/nightclubs and restaurants for Queensland and confirmed previously found associations for Western Australia. The study has shown that off-site outlet alcohol sales and total volume of alcohol sales within a region are important predictors of assault. On this basis, it is reasonable to conclude that policy decisions that ultimately increase total alcohol sales within a community or that increase numbers of on-site outlets (eg hotels/nightclubs or restaurants) are more likely to exacerbate, rather than ameliorate, harms associated with alcohol. This warrants recommendation of a precautionary approach to future liquor licensing policy formulation and application in Australian jurisdictions.

This study did not find direct evidence of a specific effect of bottleshops on numbers of assaults in Queensland; this is not in keeping with the recent Australian literature or findings from the WA models and should be treated with caution. It is possible that the results shown here for Queensland bottleshops reflect the shortcomings of the cross-sectional study design and the inability to identify sales specifically linked to bottleshops. It is also possible that the very strong associations demonstrated between Indigenous status and assault in Queensland are mediated by off-site outlet access to alcohol, and this requires further investigation.

There is current interest in finding efficient and reliable ways to inform evidence-based liquor licensing decisions. One means of encouraging the uptake of evidence-based liquor licensing policy into the future might include the construction of a data-driven tool accessible to decision makers (and possibly others), which will enable an unbiased, independent means of assessing the quantifiable outcomes from liquor licensing decisions in relation to the health and safety of communities. To achieve this in a manner that would withstand the scrutiny of the liquor licensing decision makers, industry and the community, a great deal of careful groundwork must first be undertaken. Police can support research-related activities that will encourage the uptake of data-driven liquor licensing decision making in the future by:

- supporting the investigation of liquor outlet impacts on a wide range of crime and health-related harms;
- encouraging the conduct of longitudinal research studies; and
- supporting the uptake of alcohol sales data reporting in all jurisdictions.

1.0 Introduction and Background

After caffeine, alcohol is the second most widely consumed drug worldwide (Rajendram et al. 2006) and presents a major global economic and social burden. Accordingly, over the past few decades there has been a wealth of international research exploring the potential associations between access to alcohol, alcohol consumption and alcohol-related harms. Alcohol-related problems cost Australian society $15.3b in 2004–05, contributing significantly to crime, health problems, alcohol-related road accidents and lost productivity in the workplace (Collins & Lapsley 2008). There is a growing need to assess the efficacy of current alcohol policies with a view to encouraging and enhancing evidence-based regulatory approaches and ultimately minimising alcohol-related harm. Licensed outlet density is an area that has been receiving increasing attention from policy and decision makers as well as researchers in recent years.

Australian police view alcohol as the major drug problem facing law enforcement and recognise the role that off-site (eg liquor stores, packaged liquor outlets) and on-site (eg hotels, restaurants) outlets play in relation to availability, consumption and associated harms (Nicholas 2010, 2008). The 2010 National Drug Strategy Household Survey reported that alcohol-related incidents (including physical abuse, verbal abuse or being 'put in fear') outweighed illicit drug-related incidents by a factor of three. It estimated that in 2010, 1.5 million adults were victims of alcohol-related physical abuse (AIHW 2011). Police recorded only 170,000 assaults during this time across Australia (ABS 2011). The 2011–12 Crime Victimisation Survey indicated that three-quarters of female and half of male victims knew their offender prior to physical assault. The most common location of the last physical assault for female victims was their own home (48%), followed by work/place of study (19%) and another person's home (11%). For males it was work/place of study (23%), followed by in the street or other open land (21%), and in their own home (19%). Two-thirds of victims believed that alcohol or other substances contributed to the incident (ABS 2013).

Community support for a number of measures to reduce the problems associated with alcohol significantly increased between 2004 and 2010, including—reducing the number of outlets that sell alcohol, reducing trading hours of pubs and clubs, restricting late-night trading of alcohol, strict monitoring of late-night licensed premises, increasing the price of alcohol and increasing tax on alcohol to pay for health, education and treatment of alcohol-related problems (AIHW 2011). These are measures that address both the physical and the economic availability of alcohol.

Availability theory predicts that when either physical (eg via numbers of outlets, trading hours) or economic (eg via price, taxation) availability of alcohol increases in such a way as to reduce the convenience cost of obtaining alcohol, aggregate alcohol consumption in a community rises, and with increased consumption come increased levels of alcohol-related injury, disease, disability and premature death (Stockwell & Gruenewald 2004). Several decades of epidemiological research evidence on changes and interventions that have altered the physical or economic availability of alcohol support the postulates of availability theory (Babor et al. 2010). Within this literature, there is strong evidence indicating a positive association between numbers of liquor outlets (ie outlet density) and violence.

Overall, a shortcoming of the licensed outlet density literature has been its lack of attention to alcohol sales by licensed outlets. The outlet density and violence literature is dominated by US research and, with only a few exceptions (Stevenson et al. 1998; Stockwell et al. 1998), largely comprises studies that are restricted to measuring outlet density by counting numbers of outlets and then converting them to a rate (eg per resident, per unit geographical area, per road miles) while excluding measures that quantify alcohol sales made by these outlets. A limitation inherent to count-based models (even longitudinal studies) is that they cannot account for variation between outlets and their variable capacity to influence alcohol availability in the communities in which they operate (Liang & Chikritzhs 2011). For example, a new liquor store with a large floor area and the buying power of a national corporation may have the capacity to sell hundreds of beverage brands at discounted prices with many times the capacity to influence alcohol consumption within the surrounding population than a medium-sized store specialising in boutique wines. A community that has one or more of the larger stores may be at greater risk of higher consumption and related harms than a neighbourhood that has a similar number of outlets per capita but with lower volumes of overall alcohol sales. A typical outlet density study, which essentially measures counts of outlets but not alcohol sales volume, would not be able to distinguish between these two scenarios.

This knowledge gap is a direct consequence of the worldwide paucity of information collected on alcohol sales/purchases made by liquor retailers and it is likely to have adversely affected our understanding of the impacts of liquor outlets on alcohol-related harm. The World Health Organization (WHO) recommends the collection of sales data as the gold standard in measuring alcohol consumption within communities (sales data are superior to self-reported surveys, which typically account for only about 60% of known consumption from sales data) (WHO 2006). Fortunately, in Australia, substantial efforts have recently been made to improve our knowledge base regarding the levels of alcohol available for consumption at local levels.

In response to a 2007 Ministerial Council on Drug Strategy resolution highlighting the absence of systematic and standardised Australia-wide alcohol sales data collection, which enables state and sub-state level monitoring, the Australian Government funded the development of the National Alcohol Sales Data Project (NASDP). The aim of the NASDP is to encourage the uptake of sales data recording by liquor licensing authorities in all jurisdictions, to collate these data and produce an annual report on volumes of alcohol sales by local government areas, thereby monitoring consumption trends over time (Loxley et al. 2009). The NASDP collection currently includes alcohol sales data for Western Australia, Queensland and the Northern Territory. With the support and permission of the data providers, this NDLERF-funded project will utilise liquor licensing data from Western Australia and Queensland to examine associations between outlets and violence in these jurisdictions using a cross-sectional study design.

The study will investigate the relation between rates of violence, alcohol sales and numbers of outlets in both Western Australia and Queensland. While controlling for a range of potential confounders, the cross-sectional study design will enable investigation of:

- The suitability of applying off-site outlet numbers versus alcohol sales volumes as a measurement tool for modelling and predicting future levels of problems from liquor licensing changes.
- The magnitude of the relation between alcohol sales/numbers of outlets and violence for off-site versus on-site outlets.
- Differentiated effects of off-site versus on-site outlets on levels of violence occurring at private residences versus licensed premises and other location types (eg street).

The analysis will adjust for estimated residential population and control for a range of potential demographic and socioeconomic confounders. It should be noted that while the focus of the project is on off-site outlets, it is important to include and control for potential impacts of on-site outlets throughout the modelling process.

Project aims

The primary aim of this project is to improve understanding of the relationship between off-site outlet density and alcohol-related harm in Australia. It is anticipated that the project will:

- determine the most appropriate means of measuring the strength and nature of the relationship between off-site outlets and violent assault in two Australian jurisdictions;
- identify the most effective way of using this information to predict the likely impact on the Australian community (and where possible on high-risk subgroups such as people aged under 25 years) from changes in outlet density, taking regional characteristics into account (eg socioeconomic status, urbanity); and
- develop a framework for police to map the requirements for developing an off-site outlet density model for minimising alcohol-related harms.

2.0 Literature Review

Since the early outlet density studies, methodologies in this research domain have consisted of both cross-sectional and longitudinal designs and a diverse mix of geographical areas, and have employed various approaches to analyses. Notably, some earlier studies failed to control adequately for the range of socioeconomic and demographic variables that can potentially confound apparent outcomes from outlet density analyses. Recently, however, studies have employed increasingly robust longitudinal designs and more sophisticated analyses, which have served to enhance the strength of the conclusions that can be drawn from this literature.

Search methods

This section first provides an overview of the outlet density literature in general with a focus on recent comprehensive international reviews and recent international and national studies. The review then provides a more extended detailed review of the research evidence in relation to off-site outlets. A particular emphasis was placed on Australian outlet density research. As this is a relatively large literature with a growing collection of Australian studies, to assist comprehension this section has been divided into several subsections:

1. general overview, including conclusions from recent authoritative reviews;
2. studies from the international literature;
3. Australian studies; and
4. offsite-specific literature.

A comprehensive search and review of the peer-reviewed international and national literature was carried out. All available materials published up to June 2013 were considered. Using keyword searches, electronic databases (eg Pubmed, Medline) and online journals were accessed to locate published peer-reviewed studies. The extensive internal library of the National Drug Research Institute (NDRI) was used to locate non-peer-reviewed reports.

Overview

Babor and colleagues (2010) recently provided a comprehensive review and summary of the research evidence in relation to outlet density. The authors concluded that there is ‘reasonably strong evidence that alcohol outlet density is related to alcohol-related problems, especially violence’ (Babor et al. 2010: 133). The relationship is such that as outlet density increases, harms also appear to increase. In relation to studies that have examined violence, despite problems with data quality, wide variation in geographical units used and the outlet density measure employed, a range of countries of origin and underlying assumptions, the results produced have been largely consistent. The strength of the evidence for a positive association is especially strong where studies have examined the effects of large and rapid changes in numbers of outlets (ie from natural experiments); however, the association has also been widely confirmed by a growing number of studies that have examined the impacts of more subtle changes in regulation over time.

In relation to road crashes and drink-driving, the evidence for a positive linear relationship is also apparent but less consistent and more modest than for violence. Studies have typically shown significant positive associations but some early studies found increased problems where densities were lowered—although some researchers have suggested that these early findings were artefacts of inappropriate study design and choice of geographical unit. Associations between outlet density and other harms such as homicide, child abuse and neglect, self-inflicted injury, sexually transmitted disease, alcohol-related morbidity and mortality tend to be less well established—largely due to a paucity of studies—but nonetheless appear to be both linear (at least in part) and positive.

As Babor et al. (2010: 133) have also concluded: 'The evidence supporting an association between density and alcohol consumption is mixed.' Although surveys of drinking levels in the general population or alcohol sales of specific beverage types have not always shown an effect of increased numbers of outlets, there is 'substantial evidence that outlet density is related to rates of heavy episodic drinking by youth and young adults' (Babor et al. 2010: 132). As has been argued in a recent Australian study (Liang & Chikritzhs 2011), in part, the mixed evidence for outlet density effects on overall levels of consumption may be directly related to the lack of studies that have had access to subjective data on alcohol sales (ie non-self-reported data).

Popova et al. (2009) conducted a systemic review of the outlet density literature and included peer-reviewed studies published from 2000 to 2008. In large part, the conclusions drawn by Popova et al. (2009) concurred with those made by Babor et al. (2010), Stockwell (2006) and Chikritzhs et al. (2007). They note that only a minority of studies have included actual levels of consumption (ie as opposed to alcohol-related harms), but conclude overall that:

> It is clear that alcohol management has real consequences; it can stimulate consumption and contribute to an increase in alcohol-related problems or reduce alcohol-related harm. Many problems can be reduced, or partially avoided, through careful planning and a precautionary approach. (Popova et al. 2009: 514)

Stockwell (2006: 272) concurs that there is strong evidence for an association between outlet density and population level harms, but that intervention studies and models are needed to assist community-level application.

As highlighted below, the research evidence for a positive relation between outlet density and harm has continued to grow in recent years. Although Australian studies have become more common, it nevertheless remains the case that US studies dominate the literature.

International studies

A cross-sectional study by McKinney and colleagues (2009) examined the association between intimate partner violence (IPV) and outlet density across 48 American states. A large cohort of couples was interviewed in a national survey exploring the extent to which physically violent behaviours were used against their partner. The survey also assessed drinking habits, including reported quantity and frequency of alcohol consumption over the previous 12 months. IPV was significantly greater in areas of higher alcohol outlet density, with an additional 10 alcohol outlets per 10,000 individuals accounting for a 34 percent increase in male-to-female partner violence and a 12 percent increase in female-to-male partner violence. The effect was highest among couples who self-reported problems related to their drinking.

Another recent US study, by Cunradi et al. (2012), applied a longitudinal design to examine the impact of alcohol outlets on IPV among emergency department (ED) presentations in California. Bayesian space–time modelling indicated that IPV rates differed according to type of alcohol outlet. Bar density was positively associated with IPV while off-site outlet density was negatively associated with IPV (ie protective). The authors propose that a possible explanation for these findings is that drinking in a bar environment is more likely to provoke aggression than consuming alcohol at home. They cite findings by Nyaronga and colleagues (2009) showing that risk of engaging in arguments or fights with a partner was most common among males and females who drank in bars compared with those who drank at private dwellings. Cunradi et al. (2012) also concluded that there was no association between restaurants and IPV; this finding is in keeping with other studies, including those from the United States and Australia (eg Gruenewald et al. 2006a; Lipton & Gruenewald 2002; Livingston 2010). Interestingly, an earlier ecological study by Cunradi et al. (2011) found that only off-site outlets were associated with IPV calls to police and crime reports and that bars and restaurants had no effect. Although the former study adopted a stronger longitudinal study design, the reliability with which ED staff correctly and accurately reported IPV cases may partly explain the inconsistent outcomes.

A couple of studies from New Zealand have recently contributed to the emerging international alcohol-related harm literature. Connor and colleagues (2010) used national survey data to assess both alcohol consumption and negative consequences of drinking in relation to outlet density. The survey employed measures of risky drinking, binge drinking, total consumption, alcohol-related 'harms' (eg negative impact of alcohol on friendships and social life over the previous 12 months) and alcohol-related 'troubles' (eg history of drink-driving over the previous 12 months). After adjusting for confounders, a positive association was indicated between alcohol outlets and all types of alcohol-related harms. This effect was especially marked for clubs and off-site premises. Each additional off-site outlet within 1 kilometre proximity also accounted for a four percent increase in binge drinking. As well as the cross-sectional design, a limitation of the study included the survey sample's under-representation of males, young people and those from the most socioeconomically deprived areas.

Another study from New Zealand analysed the association between police records of serious violent offences from 2005 to 2007 and geographic proximity to alcohol outlets (Day et al. 2012). All alcohol outlets within 286 police station regions were geocoded, and distance by road to the closest outlet category was calculated for each area. After controlling for socio-demographic confounders, negative binomial regression models revealed that areas with greater geographic accessibility to outlets were associated with higher levels of violent crime. Notably, off-site outlets were a predictor of serious violent crime irrespective of geographical proximity, suggesting that liquor stores may contribute more strongly to violent crime than on-site establishments.

Franklin and colleagues (2010) also investigated the relationship between alcohol outlets and violent crime using Washington, DC, census tract data. Violent crime was subdivided into four categories—robbery, homicide, sexual offences and assault. Negative binomial regression analysis identified an association between the overall number of alcohol outlets in a census tract and assault, sexual offences and robbery. Although the association between outlet density and homicide was positive, it did not reach statistical significance after controlling for confounders such as drug and weapon prevalence. When analysed separately, both on-premise and off-premise outlet density were each significantly associated with robbery but were not significantly related to the remaining three categories of violent crime. The authors concluded that violent crime is exacerbated by outlet density and that policies should be established to limit their proliferation, alcohol availability and alcohol-related violence.

A recent US study by Toomey and colleagues (2012) investigated the violent crime–outlet density relationship in urban neighbourhoods in Minneapolis, Minnesota. Four categories of violent crime were identified using police records—rape, assault, robbery and total violent crime. The analysts employed a Bayesian hierarchical inferences approach and controlled for neighbourhood demographic confounders. On-site outlet density was significantly and positively associated with all four types of violent crime. Off-site outlets were also positively associated with all categories of violence, although this relationship was not statistically significant for rape and total violent crime. The authors draw on a hypothesis set out by Gruenewald (2006) that increased violence associated with on-site outlets may be a result of higher levels of competition where concentrations of outlets occur, leading to niche marketing towards heavy consumption at greater risk of violence.

A recent cross-sectional ecological study by Grubesic et al. (2013) assessed the association between alcohol outlet density and aggravated assault in Philadelphia, Pennsylvania, analysing 1,816 'block groups'. The study was among the first to control for an indicator of local alcohol expenditures and for potentially important confounders like commercial activity, risky retailers and transportation nodes. There was a strong positive association between alcohol outlet density and violence, even after controlling for alcohol expenditures and for the densities of other retailers and other potentially risky retailers. The authors argued that the findings suggest that alcohol outlets not only attract crime but also likely generate crime that otherwise would not occur. A limitation of the study was its inability to reliably differentiate between on-site and off-site outlets and the use of self-reported expenditure data as a proxy for actual consumption.

A particularly interesting case-crossover study by Ray et al. (2008) investigated the risk of hospitalisation for assaultive injury in Ontario, Canada, taking into account alcohol sales data. They found that for every additional 1,000 litres of alcohol sold, the risk of hospitalisation for assault increased by 13 percent. The risk was highest for males (18%), people aged 13–20 years (21%) and those residing in urban areas (19%).

Resko and colleagues (2010) were among the first to explore the specific relationship between alcohol outlet density and violence in adolescents who were not yet of legal drinking age. Survey data were collated for a large sample of 14–18 year olds through an emergency department in Michigan. After controlling for individual alcohol use and demographic factors, they found that peer violence was associated with both hazardous alcohol use and alcohol outlet density; however, this association did not reach statistical significance after adjusting for neighbourhood-level socioeconomic variables. The authors suggested that their sample may have lacked statistical power to detect significant effects at the 0.05 level.

Reboussin et al. (2011) also focused on adolescents to assess whether the geographic clustering of underage drinking and related behaviours would be influenced by alcohol outlet density. Telephone interview responses were collected across five US states from a large sample of 14–20 year olds. Respondents were asked questions related to underage drinking, alcohol-related consequences, sources of alcohol and perceived alcohol availability. High off-premise density was significantly associated with attempting to purchase alcohol, successfully purchasing alcohol and riding with a drink-driver. Clusters of nonviolent alcohol-related consequences (eg having unprotected sex, passing out) were also associated with off-site outlet density, while engaging in drink-driving was specifically associated with on-site outlet density. As these results were based on retrospective self-reported responses, it is possible the data were biased by under-reporting of alcohol-related behaviours. Nevertheless, the findings generally concur with the other studies, which have also reported positive associations between outlet density, heavy alcohol consumption and related harmful behaviours in adolescents (eg Kuntsche et al. 2008; Kypri et al. 2008; Truong & Sturm 2009; Wechsler et al. 2002; Weitzman et al. 2003; Young et al. 2013).

The international literature also suggests that alcohol outlet density can compromise road safety by contributing to drink-driving (Treno et al. 2003), pedestrian injury (La Scala et al. 2001) and road crashes (Giacopassi & Winn 1995; Gruenewald et al. 1996; Jewell & Brown 1995; La Scala et al. 2001; Scribner et al. 1994; Treno et al. 2007). A Californian study by Treno et al. (2007) examined the temporal effects of changes in outlet density on alcohol-related motor vehicle crashes over a six-year period. Increases in bar and liquor store density were directly related to increases in alcohol-related car accidents. Although early findings were somewhat mixed, with some studies even showing protective effects with increased proximity (eg Stevenson et al. 1998), the positive association between outlet density and road accidents now seems to be relatively established, although notably less so than for the more robust outlet density–violence relationship.

Other harms that have been empirically linked to alcohol outlet density include child maltreatment (Freisthler 2004; Freisthler & Weiss 2008; Freisthler et al. 2005, 2004), prevalence of HIV (Nichols et al. 2012), rates of gonorrhoea (Cohen et al. 2006), self-reported injury (Treno et al. 2001) and even suicide (Johnson et al. 2009).

Australian studies

In keeping with the international literature, studies from Australia (from New South Wales, Victoria and Western Australia in particular) have consistently found associations between outlet density and crime, particularly violent crime. Several of these studies—particularly those conducted in New South Wales in the 1990s and in Western Australia—have been able to include alcohol sales data in their models. Since the 1990s, the Bureau of Crime Statistics and Research and colleagues have conducted a number of studies on outlet density in New South Wales and alcohol-related crime.

Stevenson et al. (1999b) investigated the association between assaults reported to police, alcohol wholesale purchases and per capita outlet density. Analyses were conducted separately for both metropolitan and non-metropolitan LGAs. After adjusting for confounders and spatial autocorrelation, a strong significant association between assault and total alcohol sales was found for both Sydney and country New South Wales. In Sydney, alcohol explained approximately one-quarter of the variability in assault rates, whereas in country New South Wales, alcohol accounted for only one-twentieth of the variability in violent assault.

Burgess and Moffatt (2011) recently found that recorded assaults were highly concentrated around licensed outlets in the Sydney LGA. Their calculations specifically revealed that each additional alcohol outlet per hectare in the Sydney LGA was associated with an additional 4.5 assaults every year.

When exploring the relationship between alcohol sales and property damage and public disorder, Stevenson and colleagues (1999a) focused on offence data consisting of malicious damage (eg property damage, graffiti) and offensive behaviour (ie offensive language and conduct). After controlling for confounding crime and socio-demographic variables, areas with larger alcohol sales were associated with substantially higher levels of misconduct. Again, this relationship was stronger for metropolitan Sydney than for country New South Wales. This concurs with a recent Australia-wide survey study by Wilkinson and Livingston (2012), which found that people living close to alcohol outlets were more likely to report negative amenity problems, such as property damage, noise and feeling unsafe in their neighbourhoods. Living close to on-site outlets was associated with reports of being disturbed or kept awake at night, and those living close to off-site outlets reported feeling unsafe in public as well as experiences of property damage and seeing vomit in public places.

Donnelly and colleagues (2006) similarly explored the relationship between outlet concentration (both accessibility and density) and alcohol-related neighbourhood problems, including drunkenness, property damage and assault victimisation in the home. Responses were collated from a nationwide crime and safety questionnaire and linked to geocoded locations of licensed outlets in New South Wales. After controlling for socio-demographic confounders, multilevel modelling revealed that respondents living close to alcohol outlets were significantly more likely than others to report problems related to property damage and drunkenness. Those in neighbourhoods with a greater number of outlets also reported increased levels of drunkenness and related neighbourhood problems. These results suggest that high concentrations of outlets can significantly undermine the wellbeing and amenity of surrounding communities.

Overall, findings across the NSW studies appear to suggest that the effects of outlet density on both assault rates (Stevenson et al. 1999b) and offensive behaviour (Stevenson et al. 1999a) are greater in metropolitan areas of Sydney than in country New South Wales. It is postulated that large cities and urbanised areas have a much greater flow of people and higher levels of social activity, which serve to increase opportunities for assault. It is likely, however, that a combination of ease of access to alcohol and a high concentration of intoxicated people congregating within certain areas can explain these higher levels of harm.

Since late 2000, Livingston and colleagues have undertaken a number of studies—some with longitudinal designs—of Victorian data. In Melbourne, Livingston (2008b) examined the assault–outlet density relationship longitudinally over nine years. Fixed-effects models were employed to analyse the association between alcohol outlet density and alcohol-related assaults reported to police. The entire Melbourne area was analysed and then subdivided into postcode clusters to carry out specific socio-demographic analyses. An overall positive relationship was found between all outlet types and assault, with neighbourhood type (ie suburban versus inner city) as a mediating factor. Violence in inner city and inner suburban areas was specifically related to on-site establishments, whereas suburban areas had a greater problem with violence related to off-site outlets. A more recent longitudinal study by the same author, Livingston (2011a), used Victorian hospital admission data and again found further evidence for an outlet density–assault relationship. Interestingly, Livingston (2008a) has also demonstrated a nonlinear accelerating effect of hotels/pubs on assault rates, which suggests that imposing an upper density limit on on-site establishments would likely reduce harms to surrounding neighbourhoods.

Using a cross-sectional ecological analysis, Livingston (2010) also found that general outlet density was significantly associated with IPV reported to police in Melbourne. The association remained significant after controlling for social disorganisation and economic disadvantage as confounding variables. Interestingly though, in this instance, the type of outlet seemed to have a considerable bearing on levels of domestic violence. Hotel/pub density was positively associated with domestic violence, bar and restaurant density was negatively associated with domestic violence, while off-site outlet density was not significantly associated with domestic violence in either direction. These findings confirm concerns regarding regulation of on-site premises, with particular emphasis on hotel and pub density.

Overall there is strong and consistent evidence for an association between outlet density and alcohol-related harms both internationally and in Australia. Despite this, there has been an Australian and international trend towards deregulation of the alcohol industry and the weeding out of so-called anticompetitive practices (eg Australian national competition policy) leading over time to increasing numbers of outlets (Babor 2009; Chikritzhs 2009).

Off-site outlet studies

To date, the outlet density literature has largely focused on on-site outlets. In more recent years, researchers have begun to focus on the specific association between off-site outlets and alcohol-related harm. The off-site literature is of particular interest as consumption of take-away alcohol is largely unregulated in terms of server practices, and interventions such as refusal of service to underage drinkers or intoxicated individuals is not as readily monitored in private settings.

A limitation of many outlet studies has been the inability to quantify alcohol sales and investigate the effect on surrounding communities of quantities of liquor sold. The underlying approach to the majority of outlet density studies is to count outlets and adjust the count by some measure of standardisation (eg population, road distance). This approach, however, does not allow for individual differences between off-site outlets, which can be very large. A large discount alcohol superstore in a busy area will, for instance, sell substantially more alcohol than a small boutique wine store. This discrepancy may bias results and distort the true nature of the relationship between alcohol availability and the outcome variable. Some researchers have attempted to overcome this problem by adjusting for wholesale alcohol purchases made by retailers at an aggregate level or using surveys of alcohol consumption by individuals, but these data are rarely available.

There is strong international evidence for a specific association between off-site outlet density and violence. In 1999, Scribner and colleagues conducted one of the first studies to apply geocoding technology to explore the outlet density–violence relationship. They employed this approach across 155 urban residential census tracts in New Orleans, Louisiana, and analysed homicide rates. Least squares regression analysis revealed that socio-demographic factors—including age, race, unemployment and social disintegration—contributed to 58 percent of variance in homicide rates alone. Although there was a notable absence of effect for on-site outlets, adding off-site establishment density to the model increased the variance explained to 62 percent. A 10 percent increase in off-site outlet density accounted for a 2.4 percent increase in homicide. The authors proposed that the lack of association between on-site outlets and homicide rates may be explained by the clustering of bars and restaurants predominantly catering to tourists from out of town—a demographic unlikely to commit homicide. Off-site outlets tended to be more evenly dispersed and were more likely to cater to their local neighbourhoods.

Gruenewald and Remer (2006) conducted a six-year longitudinal study to assess the effect of increasing outlet density on violent assault rates across 581 postal code areas in California. Controlling for household income and percentage of ethnic minorities, a 10 percent increase in numbers of off-site outlets was related to a 1.67 percent increase in violence rates in the local area. More recently, Branas and colleagues (2009) investigated the relationship between outlet density and the risk of being assaulted with a gun in Philadelphia. After adjusting for confounding factors, being in an area of high off-site outlet density was found to double an individual's risk of being shot in an assault, whereas there was no increased risk of being shot in areas of high on-site outlet density. Despite efforts to adjust for confounders, however, the authors noted that some residual confounding could remain. This result is consistent with another recent study, by Parker and colleagues (2011), which identified a significant positive correlation between off-site alcohol outlet density and youth homicide offence rates across the 91 largest cities in the United States.

Yu et al. (2008) used a natural experiment—in which a large number of off-site outlets in parts of Los Angeles were closed due to damage caused during civil unrest—to explore the effects of alcohol availabilty on assault. On average, and beginning one year after the unrest, a 10 percent decrease in off-site outlets saw a 2.6 percent decrease in assaults. Xu et al. (2012) evaluated the impact of policy change in New Orleans in 1997 that specifically targeted the increase in alcohol outlets across the city using a number of measures including a 35 percent increase in liquor licence fees. A significant decrease in the positive relationship between assaults and off-site outlet density was found.

Pridemore and Grubesic (2011) explored the association between different types of alcohol outlets and violence reported to police in Cincinnati, Ohio. For all types of outlet (restaurants, bars and off-site outlets), spatial density analysis revealed a significant positive relationship between outlet density and assault density.

This association was, however, notably stronger for off-site establishments, where one additional off-site outlet per square mile per six months was associated with a 60 percent increase in aggravated assaults per square mile. This concurred with a study by Gruenewald et al. (2006), which also revealed a stronger relationship between serious assaults and off-site outlet density than for bars or restaurants, which were unrelated to assault rates.

Pridemore and Grubesic (2012a) also investigated the moderating effect of land use on the outlet–assault relationship—a novel approach in the outlet density literature. General categories of land use (ie vacant, single-family residential and multi-family residential) mediated the assault–outlet density association such that it was weaker in areas with a greater proportion of single-family residences compared with the rest of the city. Pridemore and Grubesic (2012b) additionally showed that community organisation attenuated the association between off-site outlet density and aggravated assaults in Cincinnati. Thus, areas with lower levels of community organisation were at greater risk of alcohol-related harms arising from off-site outlet density.

Contrary to the findings from the studies described above, Han and Gorman (2013) found no effect for off-site outlets in their time-series analysis of violent crime in the city of Lubbock, Texas. Before September 2009, the sale of alcohol at off-site outlets was prohibited in Lubbock. A change in policy that allowed the sale of alcohol from off-site outlets provided an opportunity to assess the impact of a sudden increase in the availability of alcohol. A total of 141 off-site liquor licences were awarded in the year after the policy came into effect. No effect on violent crime reported to police was found after the rapid increase in off-site outlets. Inability to include alcohol sales and consumption data in the models and to account for possible changes in place of purchase were limitations of the study. Residents of Lubbock were, for instance, able to buy alcohol from off-site premises before the 2009 policy change from off-site outlets south of the city and in three surrounding counties.

Two recent Canadian studies explored the effect of liquor sales and alcohol-related consequences in response to partial privatisation of off-site liquor stores in British Columbia in 2002. Using multi-level regression, Stockwell et al. (2009) found a strong positive association between the number of private stores per 10,000 residents and per capita alcohol sales following increased privatisation. Specifically, a 10 percent increase in private off-site liquor outlets was found to increase overall alcohol sales by 0.28 percent. A second study by Stockwell and colleagues (2011) explored the alcohol-related harms associated with the increased number of liquor stores. The longitudinal study found a significant positive association between total number of liquor stores per 10,000 residents and rates of alcohol-related mortality. For each additional private liquor store per 10,000 residents, there was a 27.5 percent increase in alcohol-related deaths. This is consistent with a previous study conducted by Tatlow and colleagues (2000), which found that an increase of one liquor outlet per 10,000 residents led to a 48 percent increase in alcohol-related hospital admissions in San Diego, California.

Cameron et al. (2012) found a significant positive association between motor vehicle accidents and off-site alcohol outlet density in Manakau City, New Zealand. In any given area, each additional off-site licence was linked to an additional 10.3 car accidents and 85.4 additional police events. Scribner et al. (1994), on the other hand, found that traffic accidents and offences in Los Angeles County were associated with restaurant, mini-market and liquor store density, but not bar density. It is possible that different areas or types of neighbourhoods have a mediating effect on the association between off-site outlet density and road crashes.

Three recent studies have explored the relationship between off-site outlet density and domestic violence in the United States. In Sacramento, California, Cunradi and colleagues (2011) found that each additional off-site outlet in a community was associated with a four percent increase in IPV-related phone calls to police and a three percent increase in IPV-related crime reports. Notably, no such increase was found for on-site alcohol outlets. Roman and Reid (2012) used spatial econometric regression models to reveal that off-site outlet density was positively associated with domestic violence across neighbourhoods in the District of Columbia. In contrast, on-site outlets were associated with decreased levels of domestic violence, suggesting a possible protective effect of on-site establishments. It is plausible that areas with a high proportion of on-site outlets create an environment in which domestic violence is less likely to occur as people are out in public rather than at home. In contrast, Cunradi et al. (2012) found that IPV-related ED visits were negatively associated with off-site outlet density. This apparent discrepancy may be related to variability in the severity of assault between incidents reported to police and those requiring ED attendance.

Research concerning the relationship between off-site outlet density and alcohol-related harms in young people is less clear. Gruenewald and colleagues (2010) explored the relationship between outlet density and injuries, focusing on the underage and young adult demographic, and found that increased off-site outlet density was associated with significantly higher rates of injuries caused by accidents, assaults and road crashes. A longitudinal Californian study by Chen et al. (2010) found that teenagers residing in areas of high general outlet density exhibited higher initial levels of both general and harmful consumption than their counterparts in low-density areas. Other results from a cross-sectional study conducted in New Zealand (Huckle et al. 2008) and another longitudinal Californian study (Chen et al. 2009) found that both on-site and off-site outlet density were positively associated with teenage alcohol consumption.

A longitudinal survey by Shamblen and colleagues (2011) explored the relationship between off-site outlet density and alcohol use in younger populations in the United States. Students attending schools in high off-site density communities generally increased their alcohol intake between the sixth and eighth grades. Conversely, those in low outlet density communities exhibited higher levels of initial alcohol consumption, which remained relatively stable throughout the two-year study. The authors speculated that this counterintuitive pattern could occur as a result of young people in areas with fewer off-site outlets initially being more inclined to obtain alcohol from social sources compared with those living in high outlet density areas. Further research is required to delineate the nature of the effect of off-site outlet density on adolescent alcohol consumption, as well as the accompanying adverse health and social outcomes.

A number of Australian studies have recently contributed to the off-site outlet density literature specifically. Kavanagh and colleagues (2011) explored the relationship between density and proximity of off-site outlets in Melbourne and different types of alcohol-related harms. Increased off-site density was associated with increased levels of harmful alcohol consumption within the same area. Where eight or more off-site outlets occurred within 1 kilometre, the risk of drinking at levels that could cause short-term harm was significantly increased; however, no evidence for an association between outlet proximity and harmful consumption was observed. The authors suggest that alcohol availability contributes significantly towards harmful drinking in Melbourne. The cross-sectional study design is nevertheless a limitation as it is feasible that off-site outlets are more likely to be established in areas where there is already a greater proportion of individuals consuming alcohol at harmful levels.

Livingston (2011b) conducted one of the few Australian studies to have used a longitudinal design to investigate the association between alcohol outlet density and domestic violence reported to police. Time-series analysis revealed a significant positive relationship between general outlet density and levels of domestic violence in Melbourne from 1996 to 2005. Notably, however, the effect was slight for on-site establishments, while there was a substantial association between domestic violence and density of packaged liquor stores. More specifically, one additional liquor store per 1,000 residents was associated with a 28.6 percent increase in domestic violence—considerably larger than the 2.3 percent increase associated with on-site outlets. This contradicts findings from a previous cross-sectional study by Livingston (2010), which found no association between off-site outlets and domestic violence levels.

One of the most recent studies in the Australian off-site outlet density literature uniquely explored the effect of residential exposure to liquor stores on mental health problems in Perth, Western Australia (Pereira et al. 2013). Despite strong evidence for a link between alcohol consumption and a range of neuropsychiatric disorders and mental health problems (WHO 2011), the impact of alcohol outlet density on mental health has been relatively unexplored. Measures of total alcohol consumption and harmful alcohol consumption were recorded from 2006 to 2009 using the WA Health and Wellbeing Surveillance System (HWSS) Survey. Alcohol outlet density was found to be related to total alcohol consumption, and more strongly associated with harmful alcohol consumption (each additional store within a 1.6 kilometre area accounted for a six percent increase in harmful consumption). Furthermore, people living in a neighbourhood with a liquor store were 56 percent more likely to require hospital contact to treat stress, anxiety or depression than those in outlet-free neighbourhoods. This finding indicates that liquor stores can be detrimental to community mental health and wellbeing. The authors suggest that these results may underestimate the burden of mental health problems as they failed to account for problems reported to a GP or other cases where emergency intervention was not required.

Of particular relevance to the present study, Liang and Chikritzhs (2011) investigated the relationship between alcohol outlet density and violent assaults reported to police occurring at both residential and licensed settings throughout Western Australia. Unlike the majority of alcohol outlet research that focuses on numbers of outlets, the study simultaneously measured volumes of alcohol sales made my wholesalers to individual retailers. Information on type and quantity of wholesale alcohol purchases of all licensed outlets in operation was sourced, along with records on violent assault offences in LGAs in 2000–01. Increased liquor store sales were associated with a highly significant increase in reported assaults, with one additional off-site outlet accounting for a 26 percent increase in assaults occurring in private residences. Each additional off-site establishment was also found to increase violence occurring at on-site premises (ie hotels, restaurants, nightclubs) by almost 20 percent—a novel and unexpected finding in the literature.

The authors speculated that 'preloading' (consuming alcohol purchased from cheaper liquor stores prior to drinking at on-site establishments) may explain the link between off-site alcohol sales and on-site violence. There is a substantial economic advantage to purchasing and consuming cheap liquor from discount liquor stores prior to arriving at more expensive on-site outlets. These findings suggest that off-site outlets may underpin considerably more alcohol-related harm than had previously been anticipated and possibly drive more alcohol-related harm than on-site outlets. It was also noted that, had the study employed the usual methodological approach of counting outlets, the authors would have failed to correctly detect any outlet–violence relationship. This casts doubt on the reliability of the traditional approach of counting numbers of alcohol outlets, which may overlook the considerable differences in volumes of alcohol sold between different establishments.

In summary, the Australian off-site outlet literature suggests that liquor stores may contribute substantially to alcohol-related harms, especially violence. To establish causality, however, the strongest designs for future research should not only include longitudinal data but also seek to incorporate reliable estimates of alcohol sales and/or consumption into their models.

3.0 Methods

This section describes the data sources for each of the datasets used in this study and the procedures applied to prepare each for analysis for both the Queensland and the WA components of the study.

3.1 Queensland: Data sources and descriptions

Geographic unit of analysis

The geographic unit of analysis was LGA. There were 74 individual LGAs in Queensland in 2008 (see Map 1). One of the major benefits of using LGAs is that they are large in area and minimise the high levels of population mobility that occur at census collection district or postcode level, and thereby analyses based on LGA level rarely suffer from spatial autocorrelation (ie where observations from adjacent regions are correlated). As explained in detail below, however, the number of LGAs available for analysis was reduced to 59 when areas with alcohol restrictions were excluded.[1]

Using the geographic information associated with each individual licensed premise and assault (ie street address, latitude and longitude) and ArcMap v10.1, outlets and assaults were allocated to their respective 2008 LGAs.

Licensed outlet data

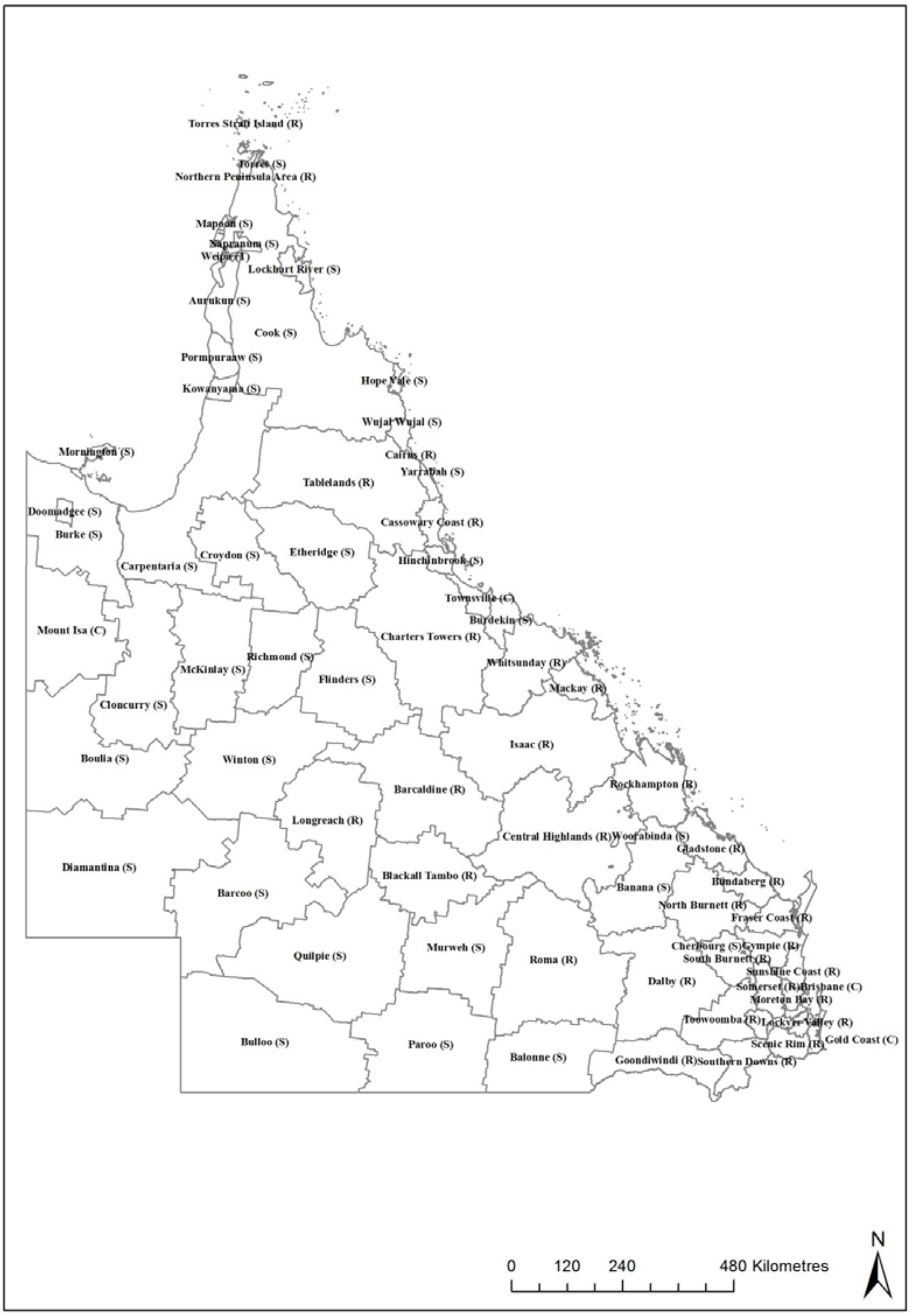
Information regarding Queensland licensed outlets in operation in 2008–09 and alcohol sales were obtained from the Office of Liquor and Gaming Regulation (OLGR) and the Office of Regulatory Policy. These data are self-reported by wholesalers to the OLGR via two annual returns:

- Return of Liquor Sales under the *Liquor Act 1992*, completed by every holder of a producer/wholesaler licence; and
- annual return under the *Wine Industry Act 1994*, completed by every holder of a wine producer or wine merchant licence.

The records provided to the project included information on—licence type (eg commercial other/subsidiary off-premise; commercial hotel; community club), site type (eg hotel, airport, caterer, school, train, wine, club etc), and volume of alcohol purchased from wholesalers by beverage type (eg regular-strength beer, low and medium-strength beer, straight spirits, premixed spirits, table wine, fortified wine, alcoholic soda).

1 One of the disadvantages of using LGA was that the relatively small number of regions would support only a parsimonious model and limited the number of explanatory variables that could be applied; however, as there were many thousands of assaults reported to police (dependent variable), statistical power was not threatened.

Map 1: Local government areas in Queensland 2008 (n=74) (C = City; R = Regional council; S = Shire; T = Town)



There are 10 ‘licence types’ and 31 different licensed ‘site types’ granted under the current Queensland liquor licensing system (see Appendix A). Within this system, however, bottleshops are not clearly identifiable with a specific site type code. It is a unique feature of the Queensland licensing system that to hold an off-site bottleshop licence, a licensee must first possess a hotel licence. Under this system, a hotel licensee may be granted up to three bottleshops that are linked to, but geographically distinct from, the primary hotel licence. Usually, the detached bottleshop(s) must also be within a 10 kilometre radius of the primary hotel. Unfortunately, in the liquor returns made by wholesalers, alcohol sales for individual bottleshops were usually combined under the primary hotel licence. Thus, it was not possible to distinguish the contribution that each of the primary on-site hotel outlets made from their linked off-site outlet(s) or to distinguish between individual bottleshops. From an analytical standpoint, this was especially problematic where off-site outlets were not in the same LGA as their primary hotel licence (in 6% of cases, detached bottleshops were outside the primary hotel's LGA).[2] When smaller regions were explored, such as a statistical local area (SLA), some 50–60 percent of bottleshops were located outside the primary hotel's region.

Therefore, although individual bottleshops could be located geographically, it was not possible to identify their individual alcohol sales. Unfortunately, this restricted the analyses that could be performed using the Queensland alcohol sales data.

On the basis of information provided about licence type and site type, liquor outlets were grouped into one of five outlet types:

- bottleshop (off-site sales only);
- hotel/nightclub;
- restaurant;
- community club; and
- other (eg motels, resorts, theatres, special facility, caterers, canteens, florists, wine merchants–tasting).

Among these licence types, 'bottleshops' represented the primary off-site outlet type. Hotel licences (but not nightclubs, which are restricted to only on-site) are permitted to sell alcohol for both on-site and off-site consumption, but no official record is kept of which hotels have attached (ie on the main premise) bottleshop/drive-through facilities. Restaurants must sell alcohol only for consumption on-site. Community clubs may sell on-site or off-site but are restricted to club members or authorised visitors only for off-site sales. The remaining 'other' licence types are largely limited to on-site sales but include some off-site-only licences for florists/guest basket operators, and some wine sales businesses.

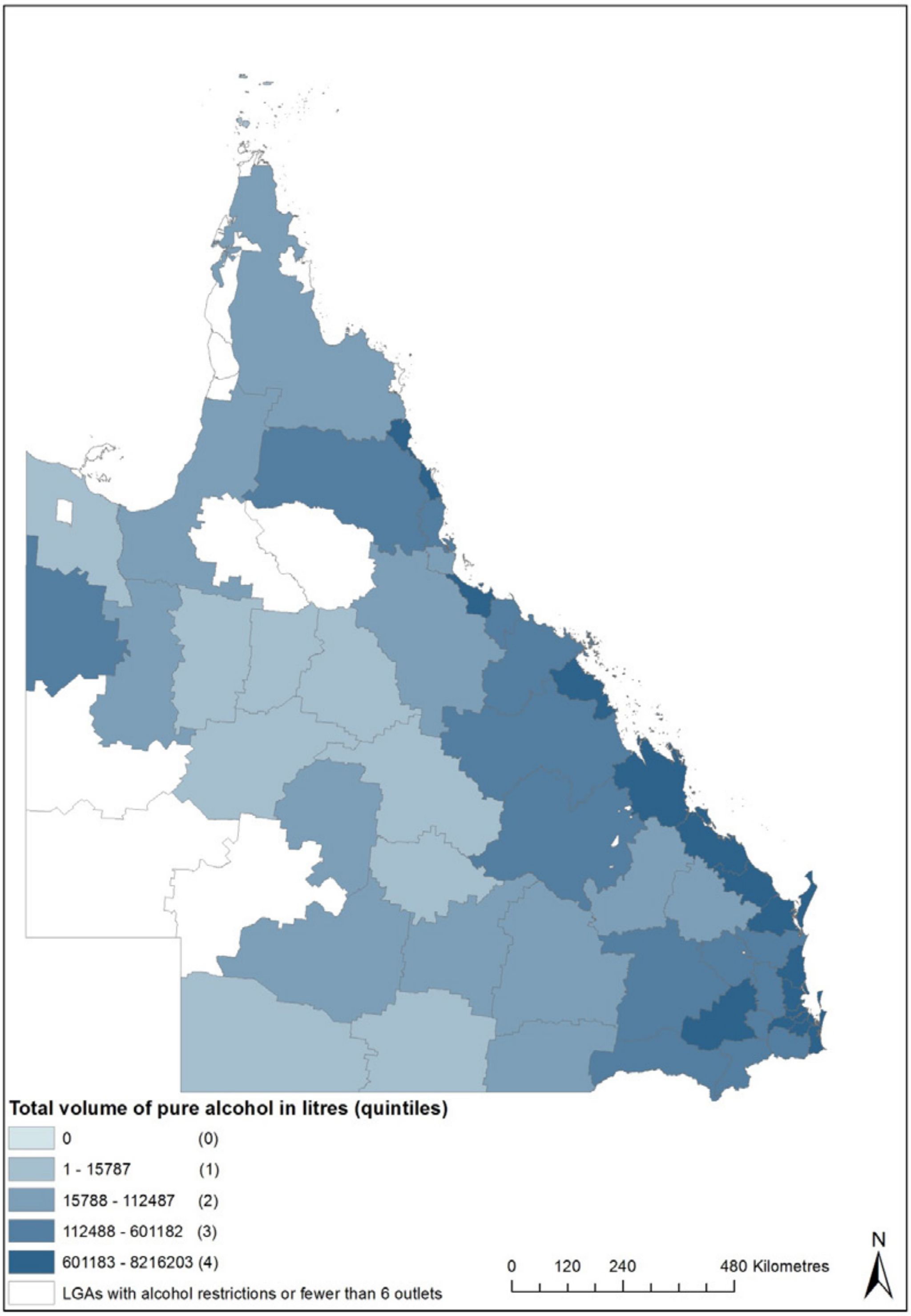
As noted above, annual wholesale alcohol purchases made by retailers were obtained from the OLGR. Although some wastage, breakage and stockpiling may occur, these annual data are considered a close proxy for actual annual retail alcohol sales made to the public (Loxley et al. 2009) and will be referred to hereinafter as alcohol 'sales'. Alcohol volumes by beverage type were converted to volumes of pure alcohol using conversion factors (see Appendix B) identified in the NASDP stage two report (Loxley et al. 2011: 37) and summed to estimate total pure alcohol sold. All premises were included in analyses, however, not all premises licensed to sell alcohol were indicated in the Queensland liquor licensing data as having purchased alcohol from licensed wholesalers in 2008–09.[3] Among community clubs and 'other' site types, the proportions of premises with no identifiable alcohol sales in 2008–09 were 43 percent and 54 percent respectively; among restaurants and hotels/nightclubs, the proportions were smaller, about 23 percent and 12 percent respectively. The proportion of bottleshops without alcohol sales in 2008–09 could not be determined.

For analyses, LGA-specific total volume of pure alcohol sales (litres) was coded to one of five groups (quintiles). Quintile ranges were based on the distribution of alcohol sales across all LGAs such that—sales group zero=0 litres; sales group one=1 to 15,787 litres; sales group two=15,788 to 112,487 litres; sales group three=112,486 to 601,182 litres; and sales group four=601,183 to 8,216,203 litres. All but two LGAs in 'sales group zero' also had alcohol restrictions; the remaining two LGAs were similar types of communities with small resident populations and zero retail outlets. Map 2 shows how the alcohol groups were distributed throughout Queensland. LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality.

2 Consideration was given to modelling an algorithm for apportioning sales volumes where aggregated among licences; however, modelling of this nature would inevitably involve a range of assumptions that would weaken the confidence that can be placed in the final results.

3 It is possible that some on-site outlets made purchases directly from off-site retail outlets—for example, community clubs that purchased alcohol from bottleshops rather than wholesalers.

Map 2: Distribution of pure alcohol sales by local government area, Queensland 2008–09 (litres)



Note: In addition to restricted areas, LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality

Assault offences reported to police

De-identified reported assaults occurring in 2008–09 were obtained from the Drug and Alcohol Coordination Unit, Queensland Police Service, and included—geographical location of offence (latitude and longitude coordinates); a description of the type of location of the offence, which distinguished between licensed outlets, dwellings and other locations; date of offence; time of day of the offence; day of week of offence; age and sex of victim; age and sex of perpetrator (where available); and type of offence (eg bodily, common, grievous bodily harm, wounding, sexual assault). Assaults were grouped according to:

- location—on-site licensed outlet, private residence, street and other;
- time of day—'night time' (10 pm to 1.59 am), 'day time' (6 am to 5.59 pm) and 'weekend' (Friday night – Sunday morning);
- victim age and sex—male, female, adult (15 years or older), child (14 years or under), people aged 15–30 years, and males aged 15–30 years; and
- assault type—serious (grievous assault, serious assault, other serious assault), sexual assault (rape and attempted rape, other sexual offences), and common assault (also restricted to victims aged 15 years or older).

Note that age, sex and type of assault groups were restricted to those records where the number of victims reported was one or more and age/sex/type were known (ie not missing).

Demographic and socioeconomic information

Estimated residential population for 2008 by LGA was obtained from the Australian Bureau of Statistics (ABS). LGA-level data on a range of variables were obtained from the ABS 2006 census data collection, including—mean age of males, mean age of females, proportion of males aged 15 years or older, proportion of Indigenous residents, and Socio-Economic Indexes for Areas (SEIFA). Other variables were the Accessibility/Remoteness Index of Australia Plus (ARIA+), guest arrivals (an indicator of tourist numbers) from the ABS Survey of Tourist Accommodation, and population density per square kilometre.

The SEIFA, the ABS index of advantage/disadvantage, was available based on the 2006 census for 2011 LGA boundaries, which were then mapped to 2008 LGAs for this project (http://profile.id.com.au/brisbane/seifa-disadvantage). The SEIFA ranks areas in terms of their relative socioeconomic advantage and disadvantage and is derived from a comprehensive range of socioeconomic measures including education, income, employment, occupation, housing and others (ABS 2008).

ARIA+ data by LGA were obtained from the Australian Population and Migration Research Centre website for 2011.[4] This is a geographical approach to remoteness in which each populated locality is given an index value of zero (high accessibility) to 15 (high remoteness) based on the road distance to the nearest service centres. The index values are then spatially interpolated to create a one kilometre grid across the country that can be aggregated to give ARIA+ values for LGAs. Each LGA was assigned an ARIA+ value as follows—one=highly accessible, two=accessible, three=moderately accessible, four=remote, and five=very remote.

The number of guests who used tourist accommodation (hotels, motels, guest houses and serviced apartments with 15 or more rooms) in each LGA in 2008–09 was obtained from the ABS Survey of Tourist Accommodation and applied as an indicator of tourism levels. The count data enabled aggregation of LGAs into five groups.[5] Based on the distribution of the number of guests over all regions, LGAs were divided into quintiles such that zero indicated a very low level of tourism and four indicated a very high level of tourism.

An estimate of population density per square kilometre was calculated using estimated residential population for 2008 by LGA and the area (in square kilometres) of each LGA. The area of each LGA was derived from ABS 2008 LGA boundary shape files using ArcMap v10.1.

4 ARIA+ was not available for 2008–09.

5 LGAs with small numbers of guest arrivals were confidentialised by the ABS.

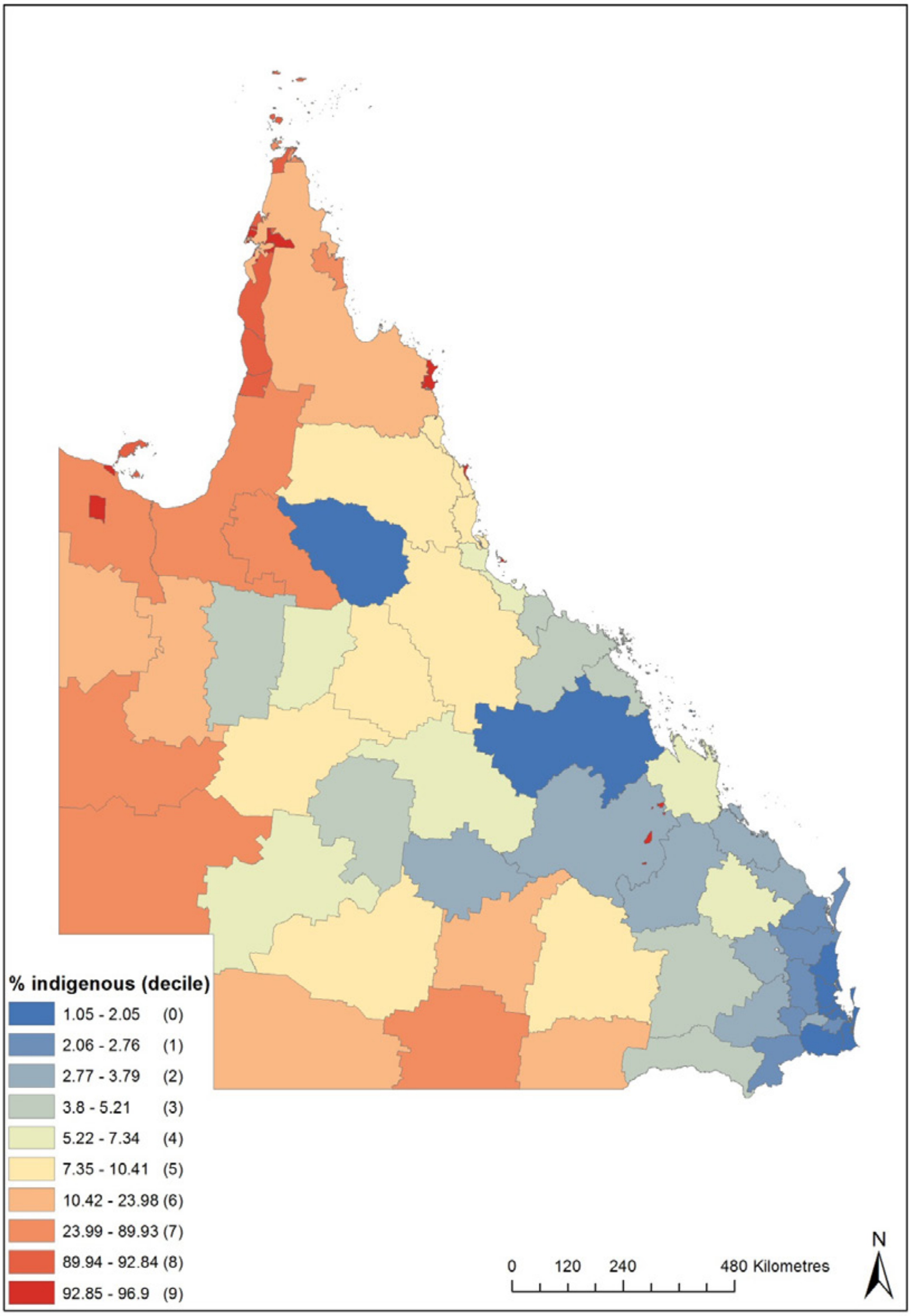
Indigenous residents and alcohol restrictions

The proportion of the population identified as Indigenous within LGAs varied widely throughout Queensland. Many LGA boundaries were deliberately assigned to describe predominantly Indigenous communities. Among a substantial proportion of LGAs, Indigenous residents were in the large majority (eg 14 LGAs had Indigenous residents exceeding 90 percent of total population); however, most LGAs with large proportions of Indigenous residents also tended to have fewer total residents overall. Conversely, some 17 LGAs with moderate to large populations had less than three percent Indigenous residents. Across all 74 LGAs, the average proportion of Indigenous residents was about 3.9 percent and the median was 7.6 percent.

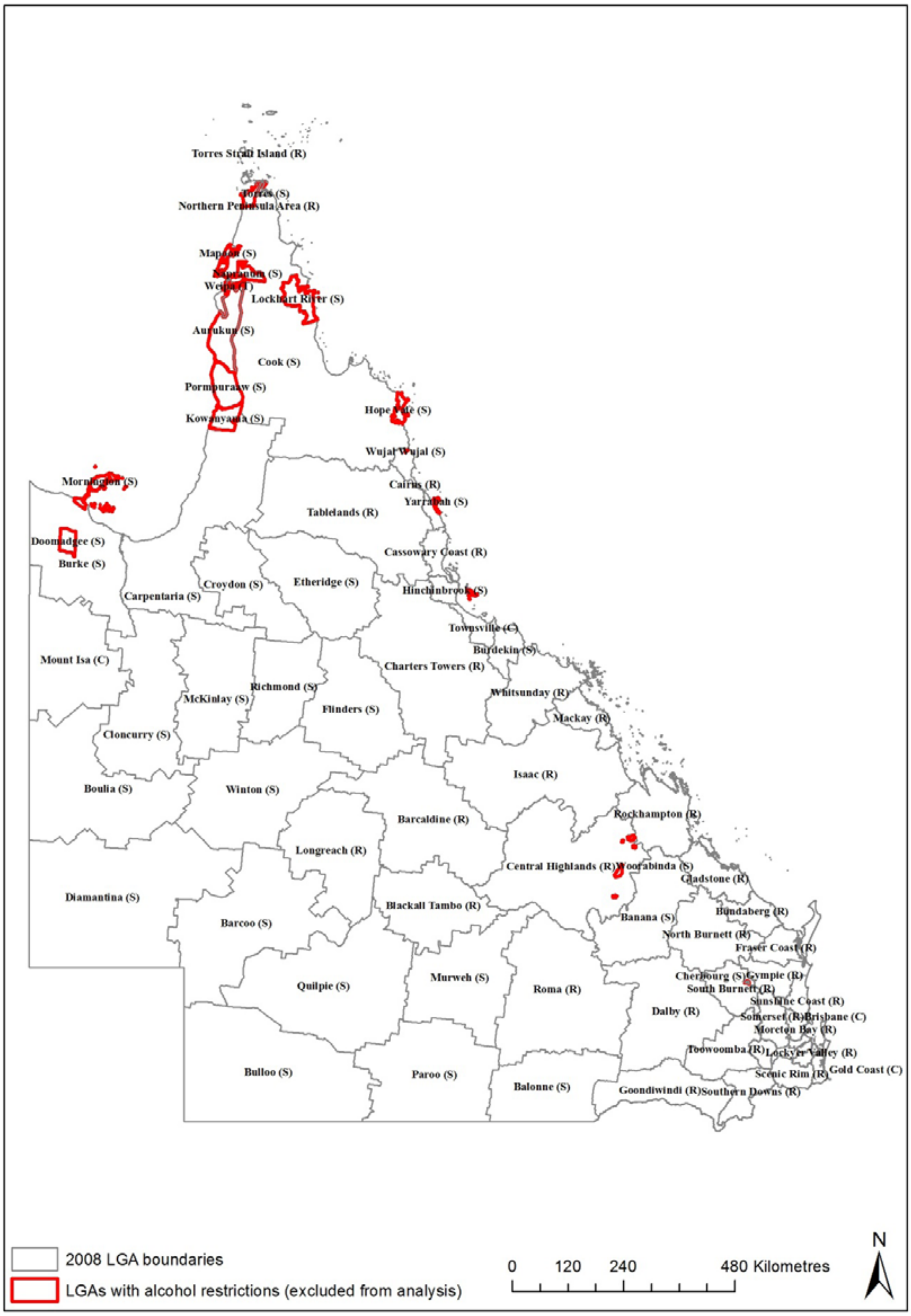
To facilitate interpretation of the effect of Indigenous populations on the risk of assault, a categorical Indigenous status variable made up of 10 groups (deciles) was constructed based on the distribution of the Indigenous residents continuous variable (zero, lowest, to nine, highest).

Alcohol restrictions have been in place in Queensland across many LGAs for some years. LGAs with alcohol restrictions (ie outright bans of alcohol sales or partial restrictions) current in 2008–09 were identified from the Queensland Department of Aboriginal and Torres Strait Islander and Multicultural Affairs website (www.datsima.qld.gov.au). LGAs with restrictions included the following—Aurukun, Cherbourg, Doomadgee, Hope Vale, Kowanyama, Lockhart River, Mapoon, Mornington, Napranum, Northern Peninsula Area, Palm Island, Pormpuraaw, Woorabinda, Wujal Wujal and Yarrabah. These LGAs were excluded from analyses. Note that all LGAs with Indigenous group code nine also had current alcohol bans and were excluded from analysis; therefore, there were only nine groups for comparison with zero as the reference group. Map 3 shows the distribution of Indigenous residents throughout Queensland LGAs and Map 4 indicates the location of alcohol-restricted LGAs.

Map 3: Percentage of residential population of Aboriginal and Torres Strait Islander origin by local government area, Queensland (2006 census data mapped to 2008 boundaries)



Map 4: Local government areas with alcohol restrictions, Queensland 2008 (C = City; R = Regional council; S = Shire; T = Town)



Mining activity

Queensland is well known for its mining activity. In many areas with high mining activity, fly-in fly-out (FIFO) workers may be common. The number of FIFO workers in an area is not well documented (and they do not appear in ERP) but their numbers may be substantial and contribute to overall levels of alcohol consumption in an area. LGAs with substantial mining activity were identified from population profiles made available on a Queensland Government website (http://statistics.oesr.qld.gov.au/qld-regional-profiles). This website enabled the generation of LGA-specific population profiles derived from ABS 2011 census data. LGAs were coded as having a major mining sector if one of two conditions was met—mining was the largest industry of employment for employed persons working in the area, or mining was the largest industry of employment for usual residents in the region. A total of 11 LGAs received a flag for mining activity, including—Weipa, Cook, Cloncurry, Central Highlands, Banana, Isaac, McKinlay, Burke, Mount Isa, Charters Towers and Mackay.

3.2 Queensland: Statistical analysis

Numbers (counts) of violent assault offences formed the dependent variable in all analyses. Multivariate negative binomial regression was the statistical test of choice given the relatively low number of assaults compared with the population and the extra-Poisson variation (ie over-dispersion as indicated by significant Alpha tests). This is a more conservative test of significance than Poisson or linear regression (STATA 2009). The results are presented as incident rate ratios (IRRs). An IRR greater than one indicates an increased risk of assault compared with the comparison group, and an IRR less than one indicates a decreased risk of assault compared with the comparison group (while holding all other variables constant). Results were considered significant if the p value was less than 0.05. STATA version 11 was used for all analyses.

When geographically arranged by LGA, the Queensland data indicate Moran's I close to zero and negligible spatial autocorrelation (ie numbers of assaults in neighbouring LGAs are spatially independent of each other). This concurs with past analyses conducted at the LGA level in Western Australia (Liang & Chikritzhs 2011).

The key explanatory variables of interest were counts of outlets by outlet type and level of total pure alcohol sales. All models simultaneously included counts of all five outlet types and level of total volume of pure alcohol sales (as a categorical variable, sales groups one–four) as well as a full complement of potential demographic and socioeconomic confounders including—ERP (natural logged), mean age of males, mean age of females, proportion of males aged 15 years or older, population density, SEIFA, Indigenous residents (zero–nine), substantial mining activity (no=zero, yes=one), ARIA+ (one–five), and tourism activity (zero–four). LGAs with alcohol restrictions (ie liquor bans) were excluded from analyses (n=15).

Five individual models were created in relation to location of the assault—total assaults, assaults at on-site outlets, assaults at residential premises, assaults in the street, and assaults at 'other' places.

Models were also created for assault by time of day and day of week, assault type and for specific subpopulations of interest based on sex and age details provided on the victim.

3.3 Western Australia: Data sources and descriptions

Geographic unit of analysis

The geographic unit of analysis was local government area (LGA). There were 139 individual LGAs in Western Australia in 2008 (see Map 5). One of the major benefits of using LGAs is that they are large in area and minimise the high levels of population mobility that occur at census collection district or postcode level, and thereby analyses based on LGA level rarely suffer from spatial autocorrelation (ie where observations from adjacent regions are correlated). As explained in detail below, however, the number of LGAs available for analysis was reduced to 135 when areas with alcohol restrictions were excluded.

Using the geographic information associated with each individual licensed premise (ie street address) and ArcMap v10.1, outlets were allocated to their respective 2008 LGAs. Assault offences were supplied with suburb as the geographic unit, so were allocated to 2008 LGAs using concordance tables supplied by the ABS.

Licensed outlet data

Since the early 1990s, the WA Department of Racing, Gaming and Liquor (DRGL) has required wholesalers to report sales made to retailers in Western Australia. This is achieved via two annual returns:

- Summary of Transaction Under a Wholesale Licence, *Liquor Control Act 1988*—this return should be completed by every holder of a Wholesaler's Licence; and
- Summary of Transaction Under a Producer's Licence, *Liquor Control Act 1988*—this return should be completed by every holder of a Producer's Licence.

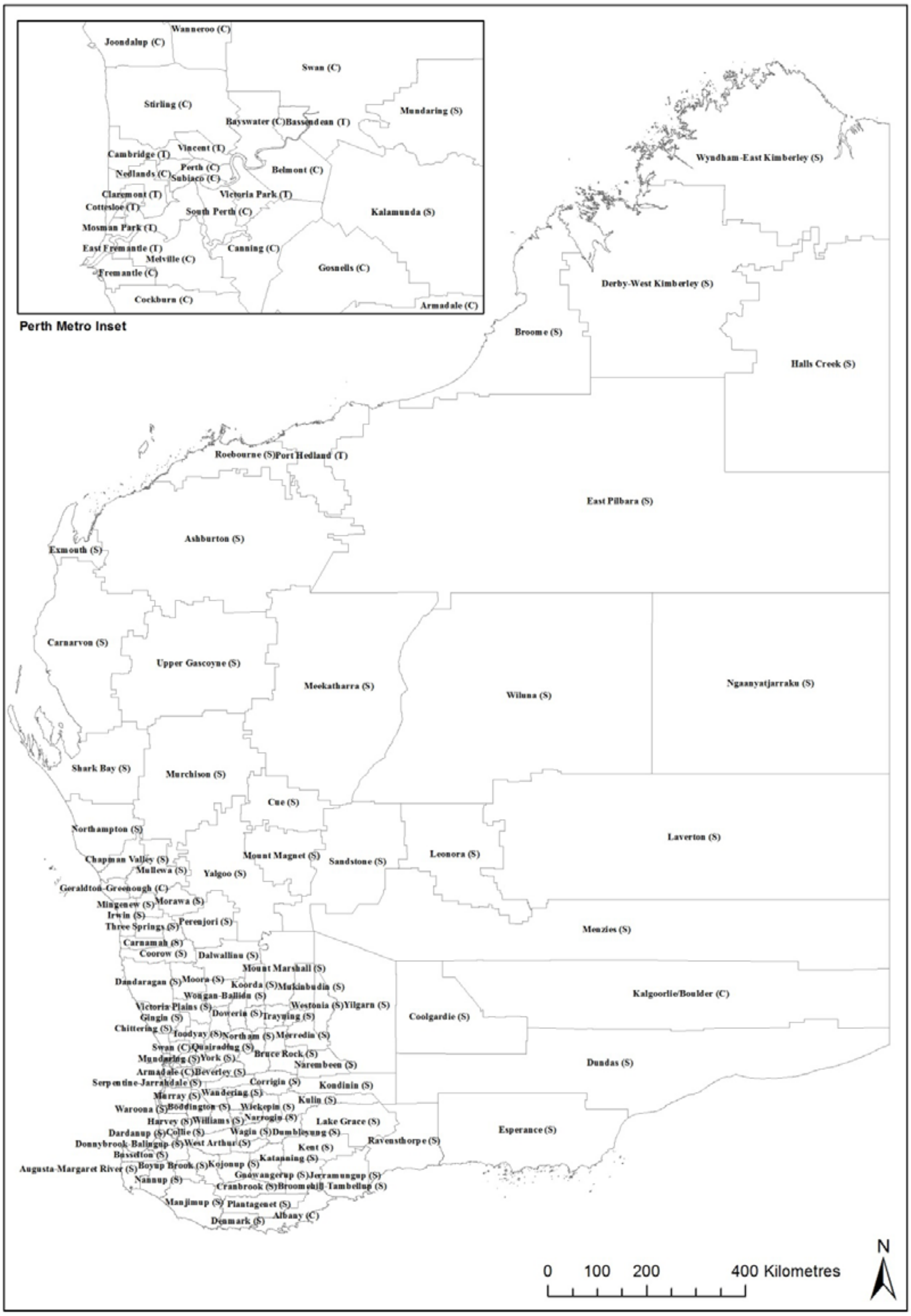
Information regarding WA licensed outlets and alcohol sales by beverage type (ie high-alcohol beer, low-alcohol beer, high-alcohol wine, low-alcohol wine, spirits) in 2008–09 was obtained from the WA Drug and Alcohol Office (DAO). There are 36 'licence types' granted under the current WA liquor licensing system (see Appendix C). On the basis of information provided about licence type, liquor outlets were separated into one of five outlet types, which were then grouped by whether they predominantly sold alcohol for off-site or on-site consumption:

- bottleshop (off-site);
- hotel/tavern, small bar, nightclub (on-site);
- restaurant (on-site);
- community club (on-site); and
- other (eg casinos, theatres, special facility, caterers, canteens, wine merchants–tasting) (on-site).

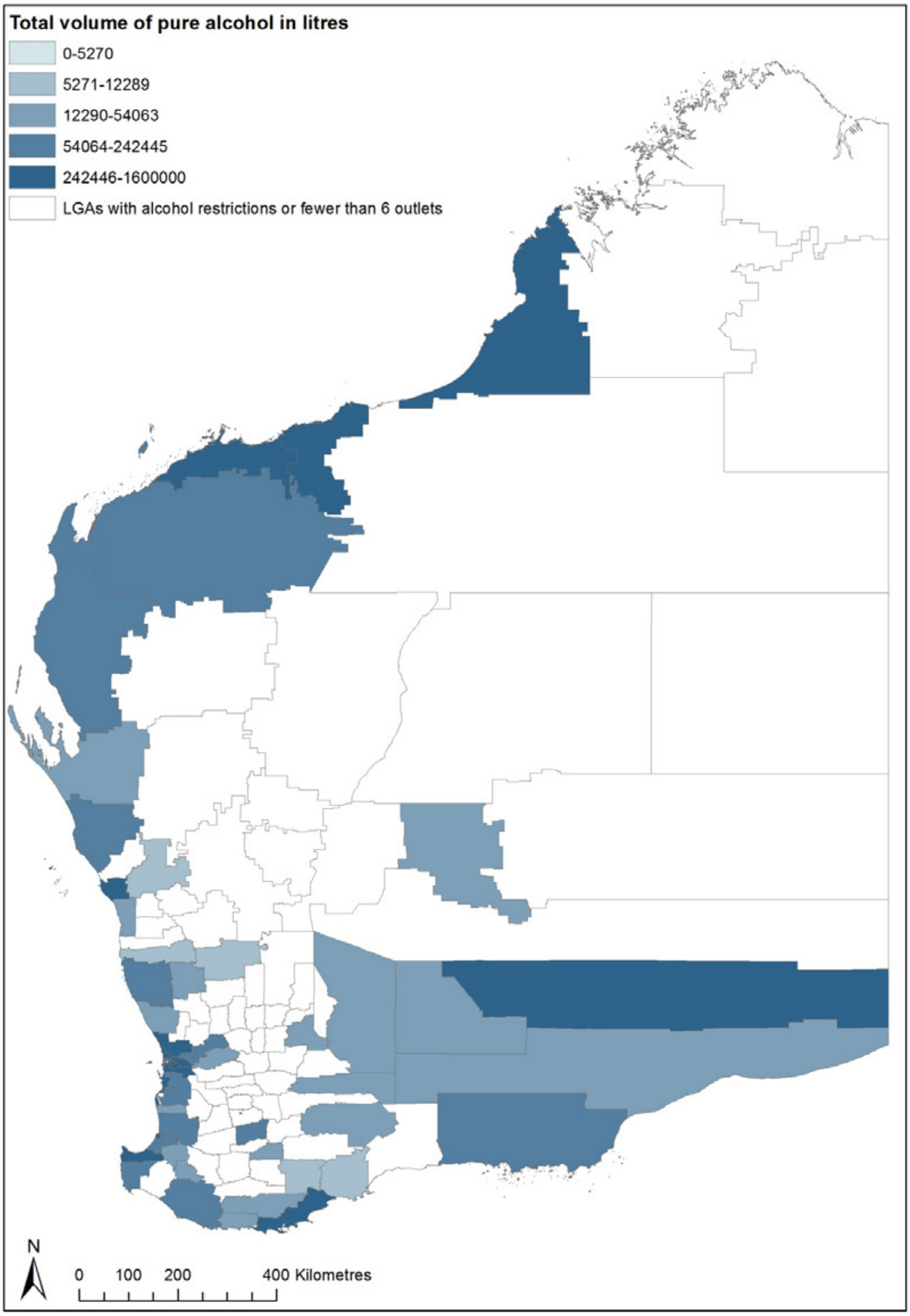
Among these licence types, 'bottleshops' represented the primary off-site outlet type. Hotels/taverns (but not nightclubs and small bars, which are restricted to only on-site sales) are permitted to sell alcohol for both on-site and off-site consumption. Restaurants must sell alcohol only for consumption on-site. Community clubs may sell on-site or off-site but are restricted to club members or authorised visitors only for off-site sales. The remaining 'other' licence types are largely limited to on-site sales but include some off-site sales under a 'special facility' such as a liquor auction. (See Appendix C for full list of WA liquor licence types.)

Although some wastage, breakage and stockpiling may occur, the annual wholesale of alcohol to retailers data are considered a close proxy for actual annual retail alcohol sales made to the public (Loxley et al. 2009) and will be referred to hereinafter as alcohol 'sales'. Alcohol volumes by beverage type were converted to volumes of pure alcohol using conversion factors (see Appendix D) identified in the NASDP stage two report (Loxley et al. 2011: 37) and summed to estimate total pure alcohol sold. Map 6 shows the distribution of volumes of pure alcohol (litres) in Western Australia, by LGA, in 2008–09.

Map 5: Local government areas in Western Australia 2008 (n=139) (C = City; R = Regional council; S = Shire; T = Town)



Map 6: Distribution of pure alcohol sales by local government area, Western Australia 2008–09 (litres)



Note: In addition to restricted areas, LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality

WA assault offences reported to police

De-identified reported assaults occurring in 2008–09 were obtained from the Liquor Enforcement Division and Business Intelligence Office, Western Australia Police, and included—geographical location of offence (suburb); a description of the type of location of the offence, which distinguished between licensed outlets, dwellings and other locations; date of offence; time of day of offence; day of week of offence; age and sex of victim; age and sex of perpetrator (where available); and type of offence (eg domestic, non-domestic, recent and historical sexual assault). Assaults were grouped according to:

- location—on-site licensed outlet, private residence, street and other;
- time of day—'night time' (10 pm to 1.59 am), and 'day time' (6 am to 5.59 pm);
- victim age and sex—male, female, adult (15 years and older), child (14 years and under),people aged 15–30 years, and males aged 15–30 years; and
- assault type—non-domestic, domestic, sexual, and attempted murder/murder/manslaughter.[6]

Note that age, sex and type of assault groups were restricted to those records where the number of victims reported was one or more and age/sex/type were known (ie not missing).

Demographic and socioeconomic information

Estimated residential population for 2008 by LGA was obtained from the ABS. LGA-level data on a range of variables were obtained from the ABS 2006 census data collection, including—mean age of males, mean age of females, proportion of males aged 15 years or older, proportion of Indigenous residents, and SEIFA. Other variables included—the ARIA+, guest arrivals (an indicator of tourist numbers) from the ABS Survey of Tourist Accommodation, and population density per square kilometre.

The SEIFA, the ABS index of advantage/disadvantage, was available based on the 2006 census for 2011 LGA boundaries, which were then mapped to 2008 LGAs for this project (http://profile.id.com.au). The SEIFA index ranks areas in terms of their relative socioeconomic advantage and disadvantage and is derived from a comprehensive range of socioeconomic measures including education, income, employment, occupation, housing and others (ABS 2008).

ARIA+ data by LGA were obtained from the Australian Population and Migration Research Centre website for 2011.[7] This is a geographical approach to remoteness in which each populated locality is given an index value of zero (high accessibility) to 15 (high remoteness), based on the road distance to the nearest service centres. The index values are then spatially interpolated to create a one kilometre grid across the country, which can be aggregated to give ARIA+ values for LGAs. Each LGA was assigned an ARIA+ value as follows—one=highly accessible, two=accessible, three=moderately accessible, four=remote, and five=very remote.

The number of guests who used tourist accommodation (hotels, motels, guest houses and serviced apartments with 15 or more rooms) in each LGA in 2008–09 was obtained from the ABS Survey of Tourist Accommodation and applied as an indicator of tourism levels. The count data enabled aggregation of LGAs into three groups.[8] Based on the distribution of the number of guests over all regions, LGAs were divided into tertiles such that zero indicated a very low level of tourism and two indicated a very high level of tourism.

An estimate of population density per square kilometre was calculated using the estimated residential population for 2008 by LGA and the area (in square kilometres) of each LGA. The area of each LGA was derived from ABS 2008 LGA boundary shape files using ArcMap v10.1.

6 Numbers of cases were very small.

7 ARIA+ was not available for 2008–09.

8 LGAs with small numbers of guest arrivals were confidentialised by the ABS.

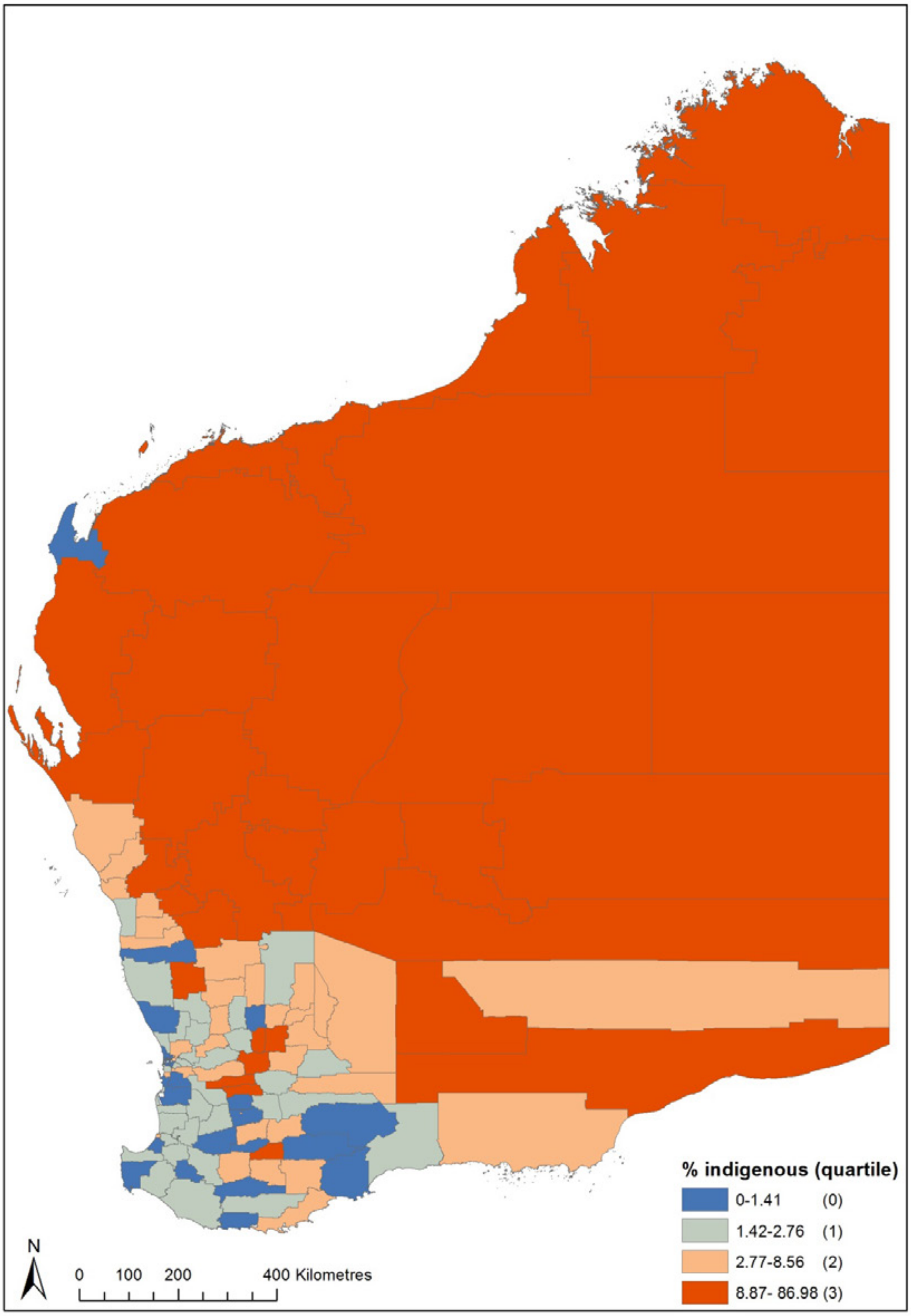
Indigenous residents and alcohol restrictions

The proportion of the population identified as Indigenous within LGAs varied widely throughout Western Australia. Compared with Queensland, in Western Australia, only in a small proportion of LGAs were Indigenous residents in the majority (eg five LGAs had Indigenous residents exceeding 50% of the total population). Some 75 LGAs with moderate to large populations had less than 3 percent Indigenous residents. Across all 139 LGAs, the average proportion of Indigenous residents was about 8.5 percent, and the median was 2.8 percent. Map 7 shows the distribution of Indigenous residents throughout WA LGAs.

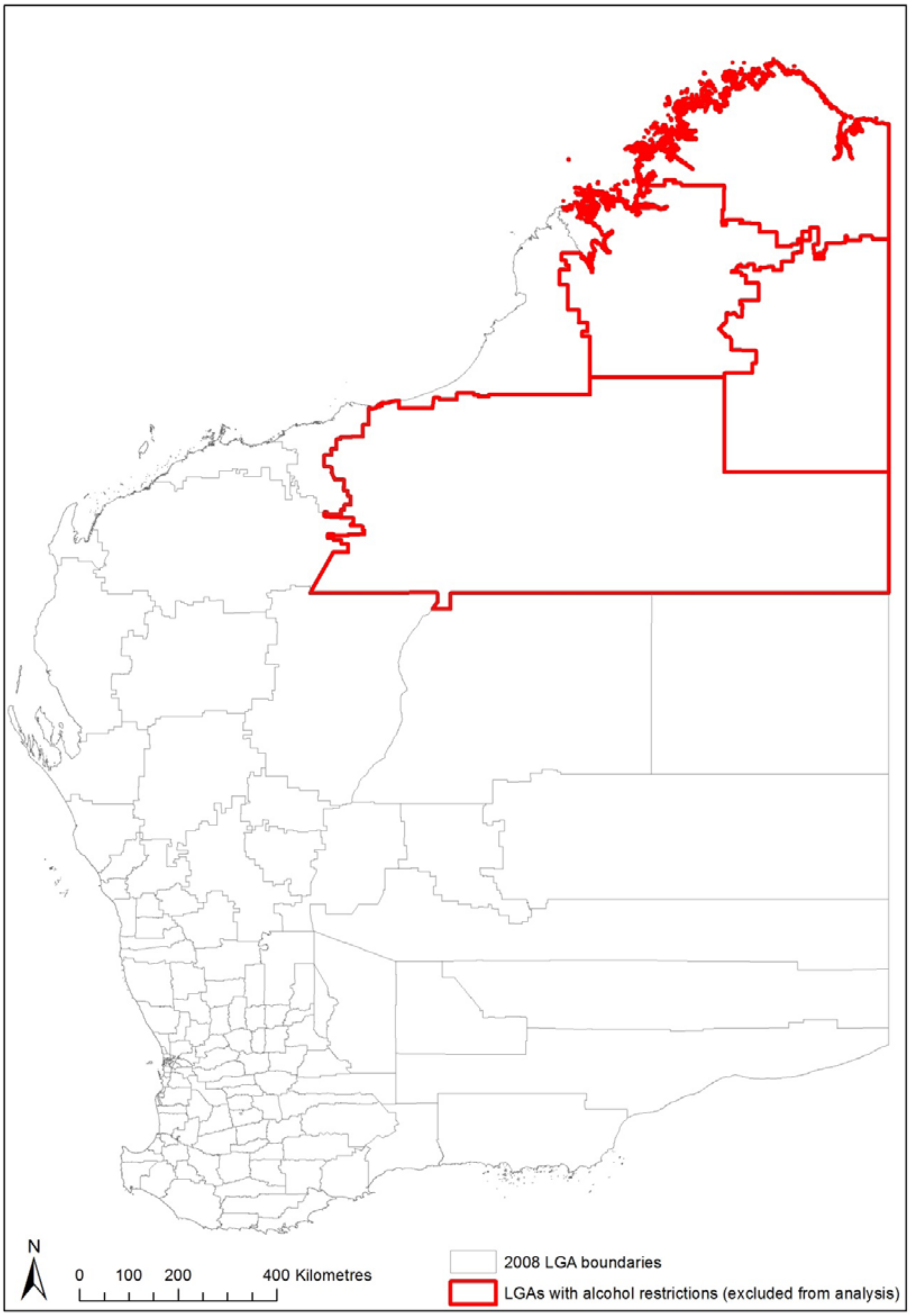
To facilitate interpretation of the effect of Indigenous populations on the risk of assault, a categorical Indigenous status variable made up of four groups (quartiles) was constructed based on the distribution of the Indigenous residents continuous variable (zero as the lowest to three as the highest).

LGAs with alcohol restrictions (defined as LGAs that contained at least one dry community under Section 175 of the Liquor Control Act 1988) in 2010 were identified from the Department of Racing, Gaming and Liquor website. LGAs that included dry communities were—Derby–West Kimberley, East Pilbara, Halls Creek and Wyndham–East Kimberley. These four LGAs were excluded from analyses. Map 8 shows the LGAs with such alcohol restrictions.

Map 7: Percentage of residential population of Aboriginal and Torres Strait Islander origin by local government area, Western Australia (2006 census data mapped to 2008 boundaries)



Map 8: Local government areas with alcohol restrictions in 2010 (LGAs that contained at least one dry community under Section 175 of the Liquor Control Act 1988), Western Australia



Mining activity

Like Queensland, Western Australia is also well known for its mining activity. In many areas with high mining activity, FIFO workers may be common. LGAs with substantial mining activity were identified from the ABS 2011 census. LGAs were coded as having a major mining sector if one of two conditions was met—mining was the largest industry of employment for employed persons working in the area, or mining was the largest industry of employment for usual residents in the region. A total of 26 LGAs received a flag for mining activity.

3.4 Western Australia: Statistical analysis

Numbers (counts) of violent assault offences formed the dependent variable in all analyses. Multivariate negative binomial regression was the statistical test of choice given the relatively low number of assaults compared with the population and the extra-Poisson variation (ie over-dispersion as indicated by significant Alpha tests). This is a more conservative test of significance than Poisson or linear regression (STATA 2009). The results are presented as IRRs. An IRR greater than one indicates an increased risk of assault relative to the comparison group and an IRR less than one indicates a decreased risk of assault relative to the comparison group (while holding all other variables constant). Results were considered significant if the p value was less than 0.05. STATA version 11 was used for all analyses.

When geographically arranged by LGA, the WA data indicate Moran's I close to zero and negligible spatial autocorrelation (ie numbers of assaults in neighbouring LGAs are spatially independent of each other). This concurs with past analyses conducted at the LGA level in Western Australia (Liang & Chikritzhs 2011).

The key explanatory variables of interest were counts of off-site and on-site outlets per 10,000 adults aged 15 years or older, and average pure alcohol sales per outlet per adult aged 15 years or older for off-site and on-site outlets. All models simultaneously included a full complement of potential demographic and socioeconomic confounders, including—ERP (natural logged), mean age of males, mean age of females, proportion of males aged 15 years or older, population density, SEIFA, Indigenous residents (zero–three), substantial mining activity (no=zero, yes=one), ARIA+ (one–five), and tourism activity (zero–two). LGAs that included communities with complete alcohol bans were excluded from analyses (n=4).

Five individual models were created in relation to location of the assault—total assaults, assaults at on-site outlets, assaults at residential premises, assaults in the street, and assaults at 'other' places. Models were also created for assault by time of day and day of week, assault type and for specific subpopulations of interest based on sex and age details provided on the victim.

It is important to note in relation to the analyses applied to WA data that there are several differences between the approach taken in this study and that taken in the Liang and Chikritzhs (2011) study that preclude the precise comparison of estimated risks. The current study offers a substantial improvement on the Liang and Chikritzhs (2011) approach. It includes several control variables that were not taken into account in the earlier WA work, including the presence of alcohol restrictions, mining activity and tourism activity. The results demonstrate that these are important variables and that including them enhances the accuracy of the models. Moreover, the current WA models used an arguably improved measure of off-site and on-site outlet sales volume. The Liang and Chikritzhs (2011) approach to measuring volume took account of ERP by including it as a potential confounder in the models but did not include adult population in the rate. The current model specifies population (per adult aged 15 years or older) in the rate in addition to controlling for ERP in the model. This is arguably a more robust approach to representing risk as it takes better account of population size variability across regions.

4.0 Results

This section has been divided into several subsections, each relating to separate descriptive and multivariate results for Queensland and Western Australia.

4.1 Queensland: Descriptive results

This section describes the Queensland liquor outlet and assault datasets.

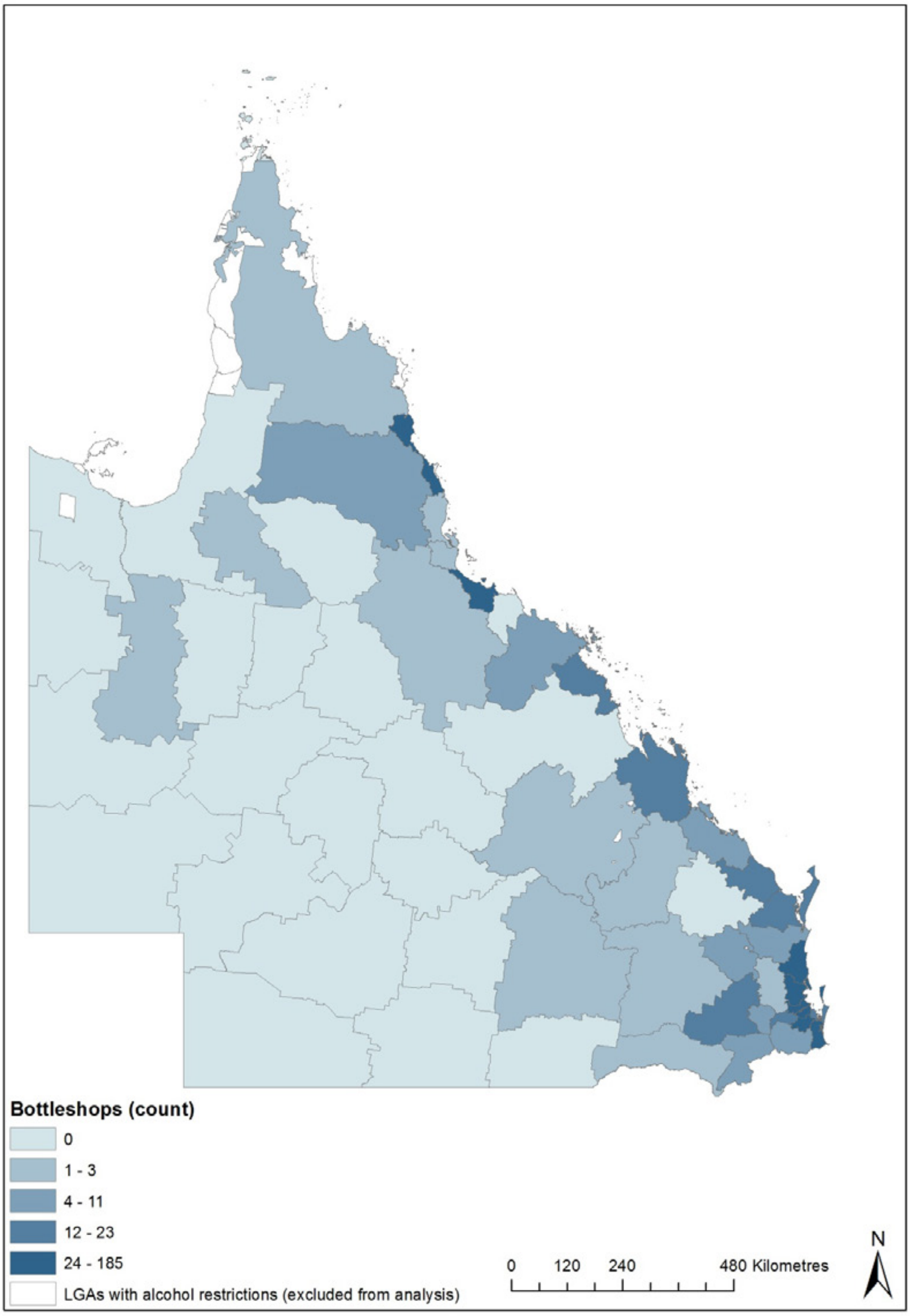
Liquor outlets

There were more than 6,900 licensed outlets in Queensland in 2008–09. Table 1 lists numbers of outlets by outlet type. Maps 9 to 13 show the distribution of Queensland alcohol outlets by type. As would be expected, the number of outlets is highest in the more populated LGAs along the coast. This pattern is reversed when taking the estimated residential adult population into account (Map 14), with the highest number of alcohol outlets per 1,000 adults occurring in the more remote and less-populated inland LGAs.

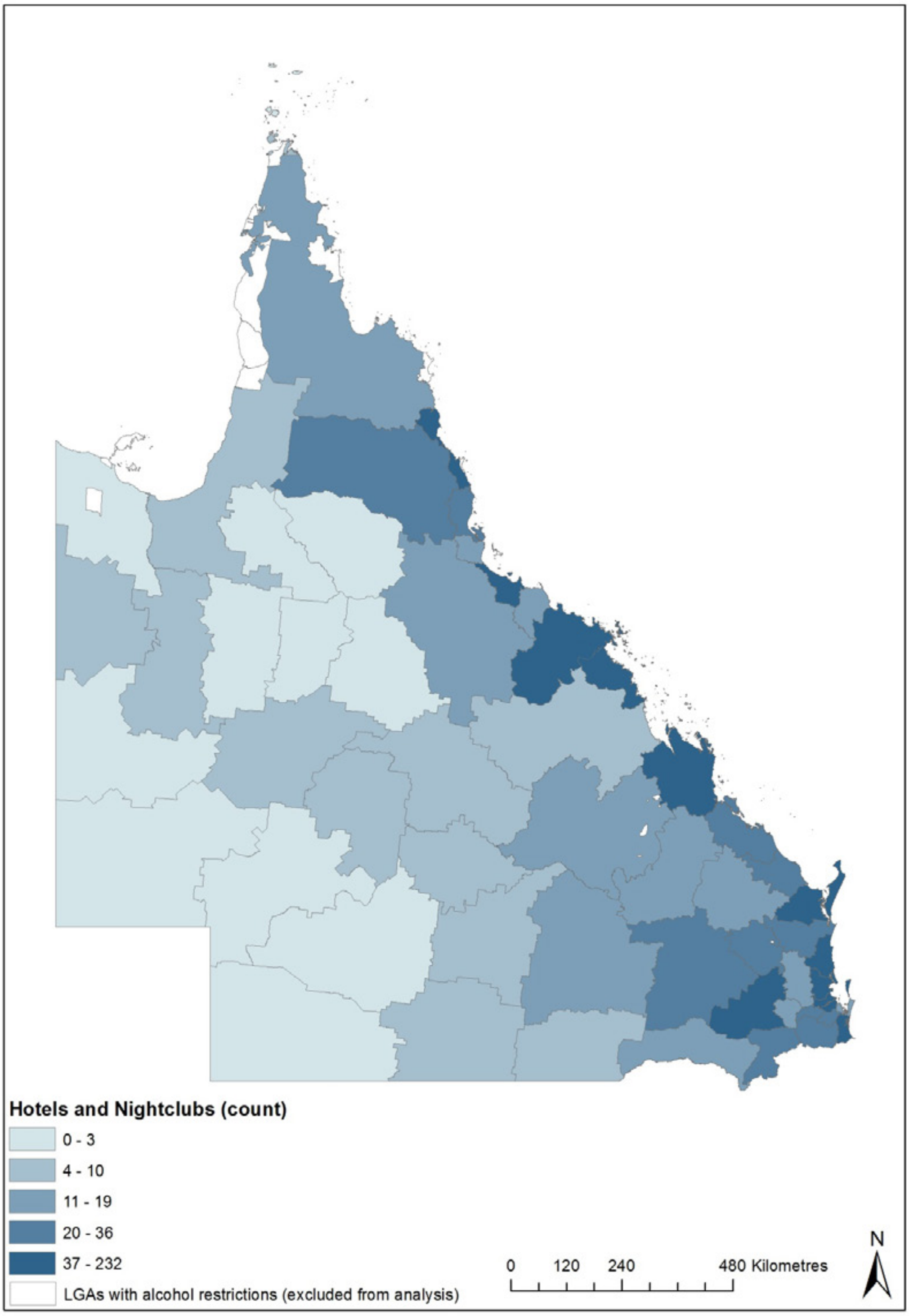
Table 1: Number of outlets by type, Queensland 2008–09

Outlet type	n	%
Bottleshop (detached)	730	10
Hotel/nightclub	1,460	20
Restaurant	2,042	28
Community club	1,200	16
Other	1,891	26
Total	7,323	100

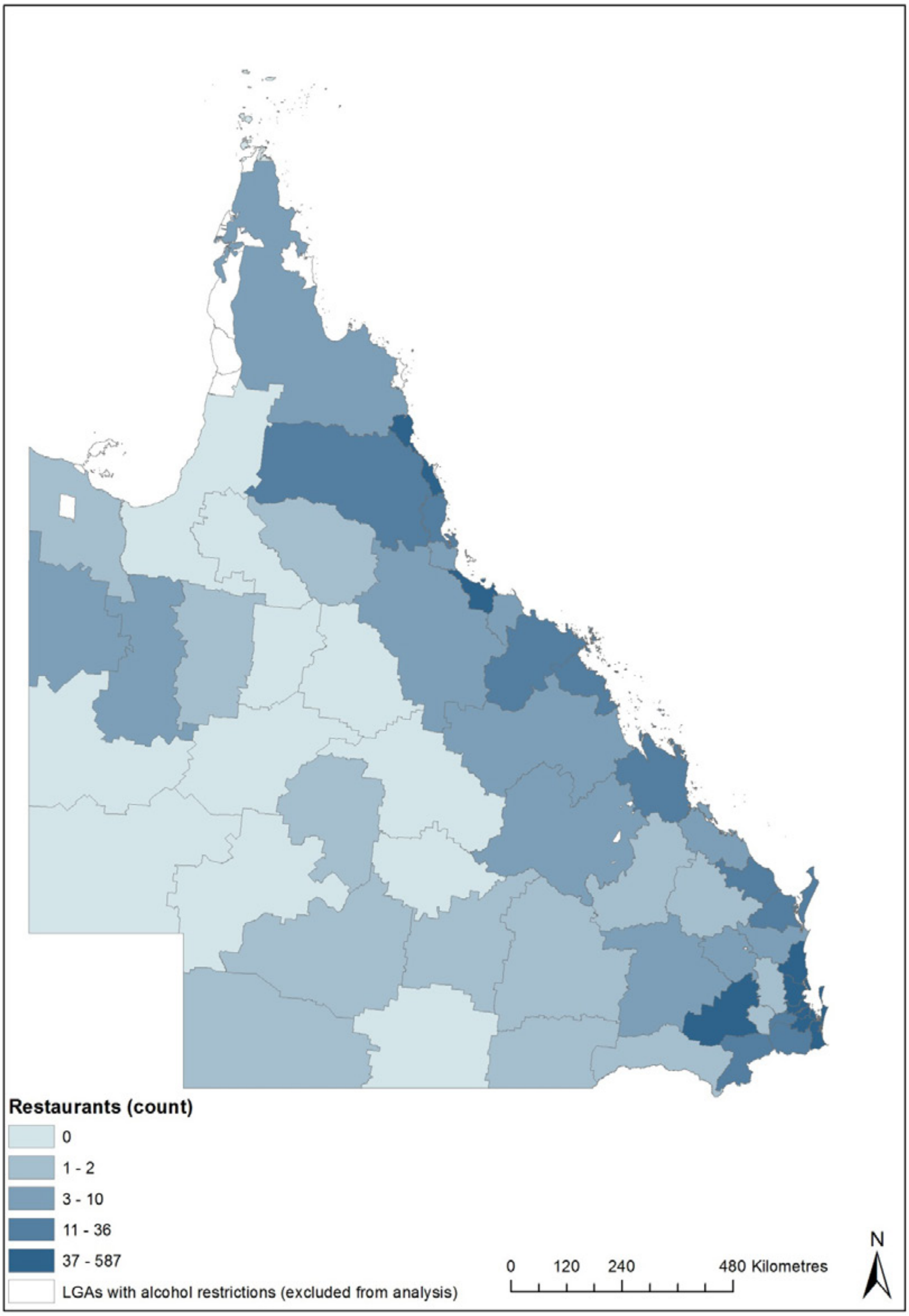
Map 9: Distribution of detached bottleshops (off-site) by local government area, Queensland 2008–09



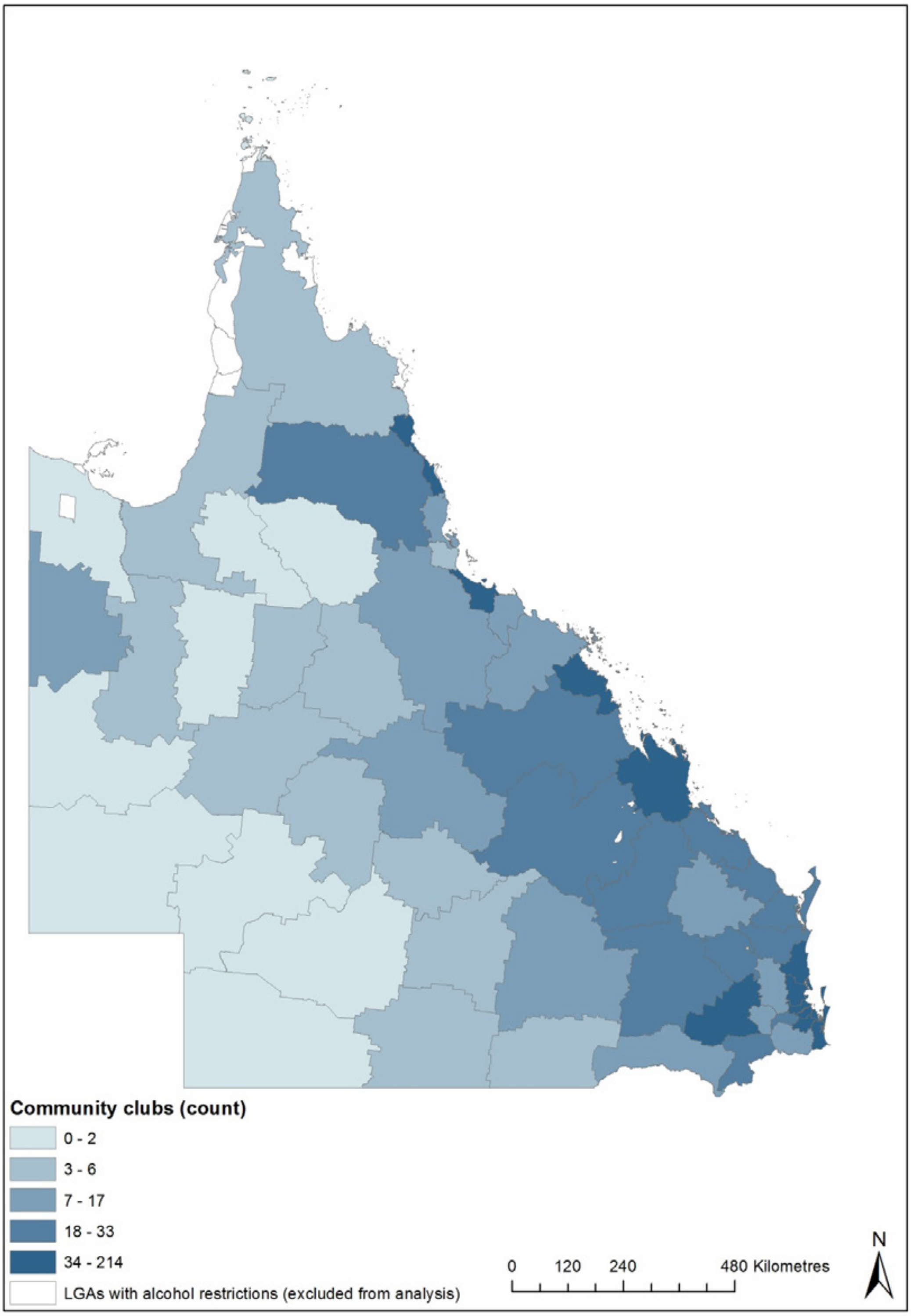
Map 10: Distribution of hotels and nightclubs by local government area, Queensland 2008–09



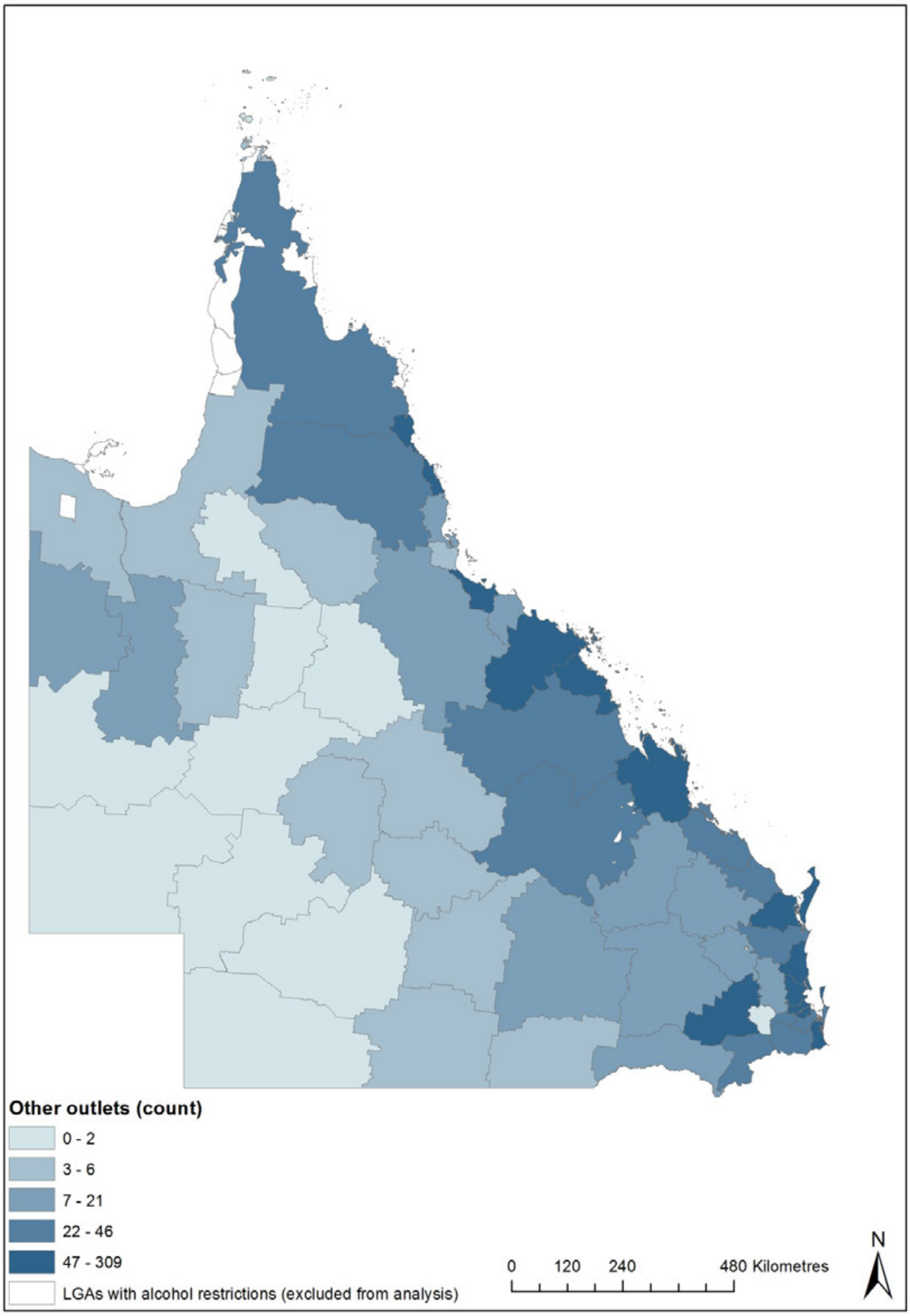
Map 11: Distribution of restaurants by local government area, Queensland 2008–09



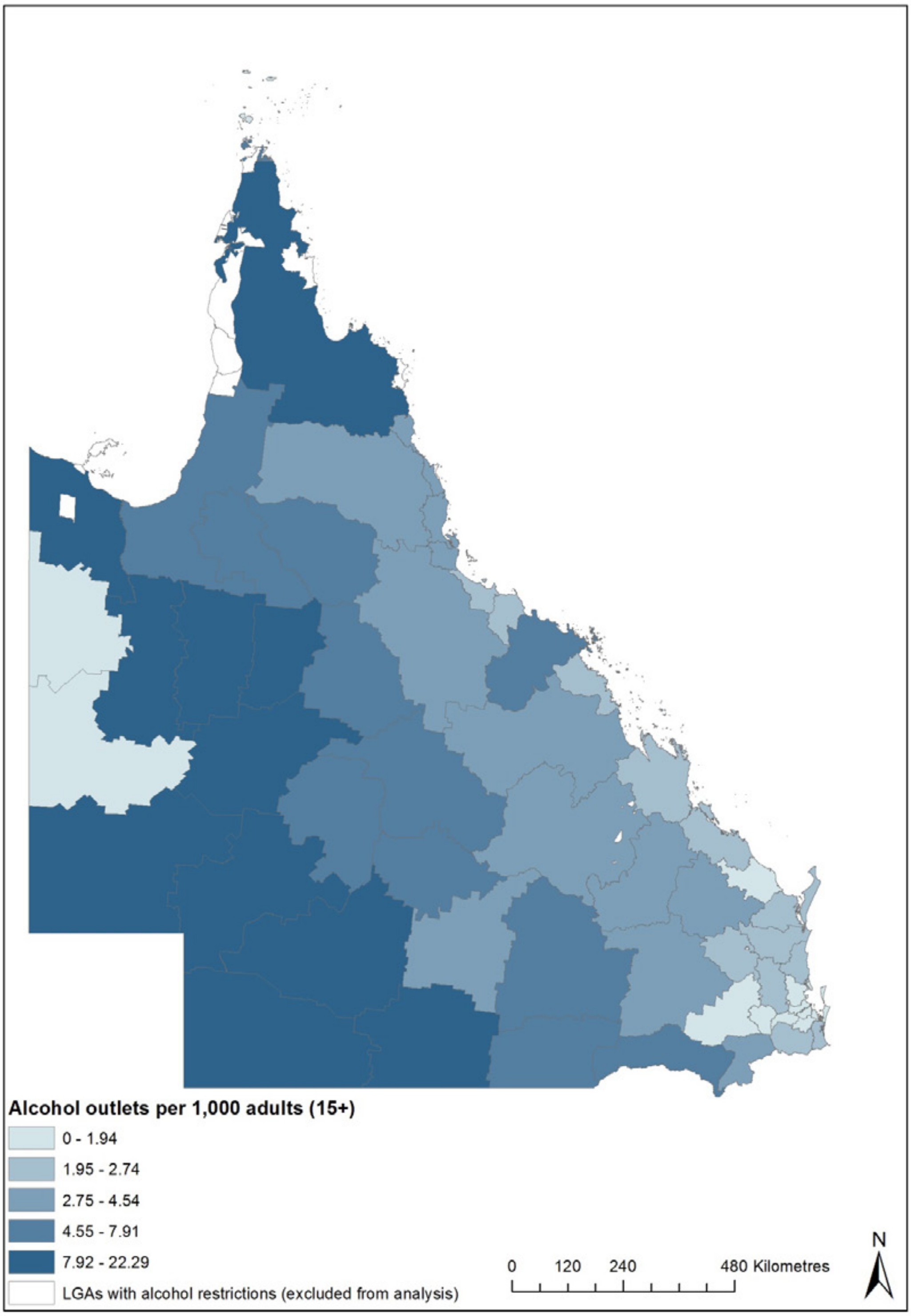
Map 12: Distribution of community clubs by local government area, Queensland 2008–09



Map 13: Distribution of 'other' outlets by local government area, Queensland 2008–09



Map 14: Distribution of all alcohol outlets per 1,000 adults (aged 15 years or older) by local government area, Queensland 2008–09



Although total volumes of alcohol sales could not be accurately estimated by outlet type (due to the merging of hotel and bottleshop sales data, as outlined in the Queensland methods section), data were sufficiently reliable to show estimate of sales at the LGA level. Table 2 provides summary statistics by beverage type for the whole of Queensland, and Maps 15 and 16 show the distribution of per capita alcohol consumption for those aged 15 years or older[9] by LGA and total pure alcohol sales volumes quintiles (sales groups) respectively. The distribution of total pure alcohol volume is as expected, with the highest volumes purchased in the most populated coastal LGAs. The distribution is very different, however, when population is taken into account, in which case per capita consumption for adults is highest among more remote areas.

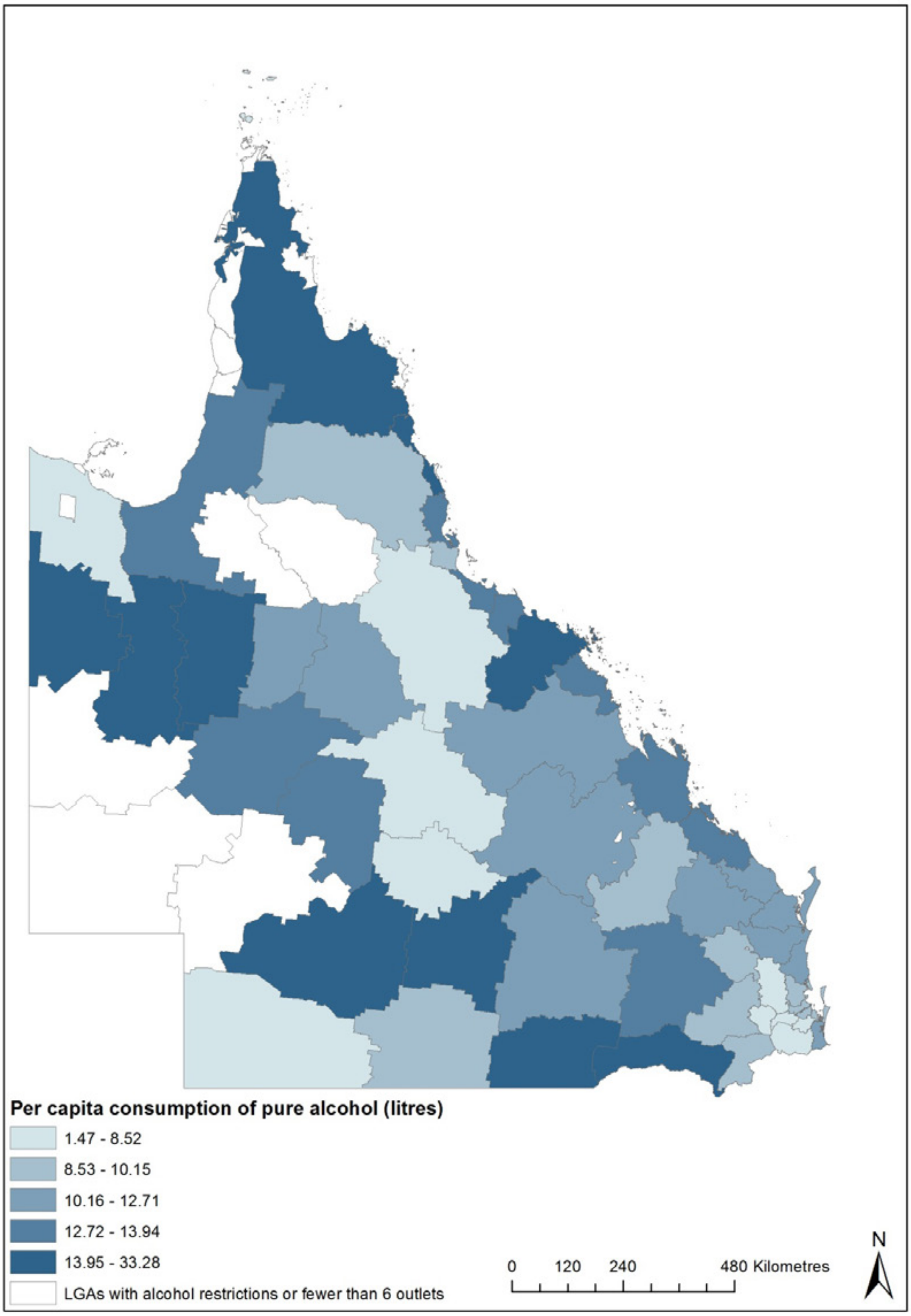
Table 2: Mean volumes of pure alcohol purchased per local government area by beverage type, Queensland 2008–09 (litres)

Beverage type	Mean (L)	Std Dev.
Regular-strength beer	131,334	344,982
Low/mid-strength beer	103,820	187,706
Wine (bottled)	89,686	285,031
Cask wine	50,497	117,024
Straight spirits	88,343	216,970
Pre-mixed spirits	38,175	79,716
Totala	511,366	1,231,027

a: Includes small volumes mead, fortified wine, alcoholic soda and cider

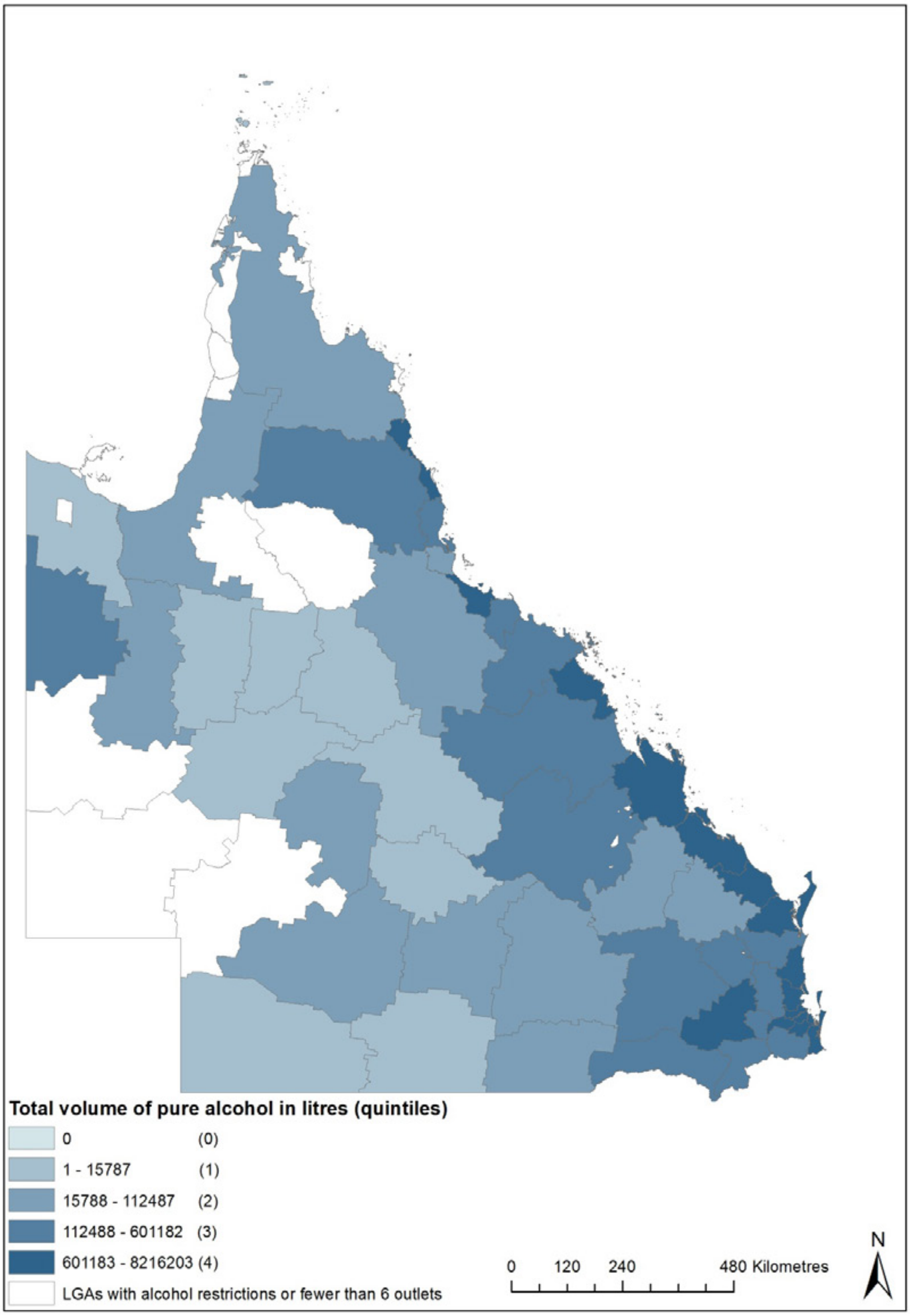
9 LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality.

Map 15: Per capita consumption of pure alcohol by local government area, Queensland 2008–09 (litres)



Note: In addition to restricted areas, LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality

Map 16: Distribution of total pure alcohol sales by local government area, Queensland 2008–09 (litres)



Note: In addition to restricted areas, LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality

Assault offences reported to police

More than 24,500 assault offences reported to police occurred in Queensland in 2008–09—a population rate of about 7.1 assaults per 1,000 persons aged 15 years and over resident in Queensland. Table 3 shows frequencies of assault by location, victim demographics, assault type and time of day. Only 10 percent of assaults occurred at on-site licensed premises while 32 percent occurred at private residences. Among assaults where the victim's details were completed, some 51 percent were classed as serious assaults, 34 percent as common and 16 percent as sexual. There were more assaults committed against male victims than female victims and the majority was committed against adults (76 percent).

Map 17 shows the distribution of numbers of assaults among Queensland LGAs in 2008–09. As expected, the number of assaults was highest in the more populated LGAs, but the rate of assault per 1,000 adults (Map 18) was highest in the more remote areas, particularly in the northwest of the state.

Table 3 Numbers of assaults and mean number of assaults per local government area by category, Queensland 2008–09

	Total n (all 74 LGAs)	Mean (across LGAs)	Std dev. (across LGAs)
Total assaults[a]	24,512	331	673
Location			
On-site	2,475	33	82
Private residence	7,893	111	197
Street	6,068	82	179
Other	8,076	109	235
Victim age and sex[b]			
Male	12,420	168	376
Female	10,508	142	260
Adult (15+ years)	18,684	252	533
Child (0–14 years)	4,302	58	107
Young (15–30 years)	10,203	72	171
Young male (15–30 years)	5,320	72	171
Assault type[c]			
Serious	12,400	168	338
Sexual	3,820	52	107
Common	8,291	112	231
Serious (15+ years)	10,109	140	284
Sexual (15+ years)	1,908	27	60
Common (15+ years)	6,667	93	198
Time of day[d]			
Night time	7,707	104	215
Day time	9,702	131	259
Weekend	10,636	148	316

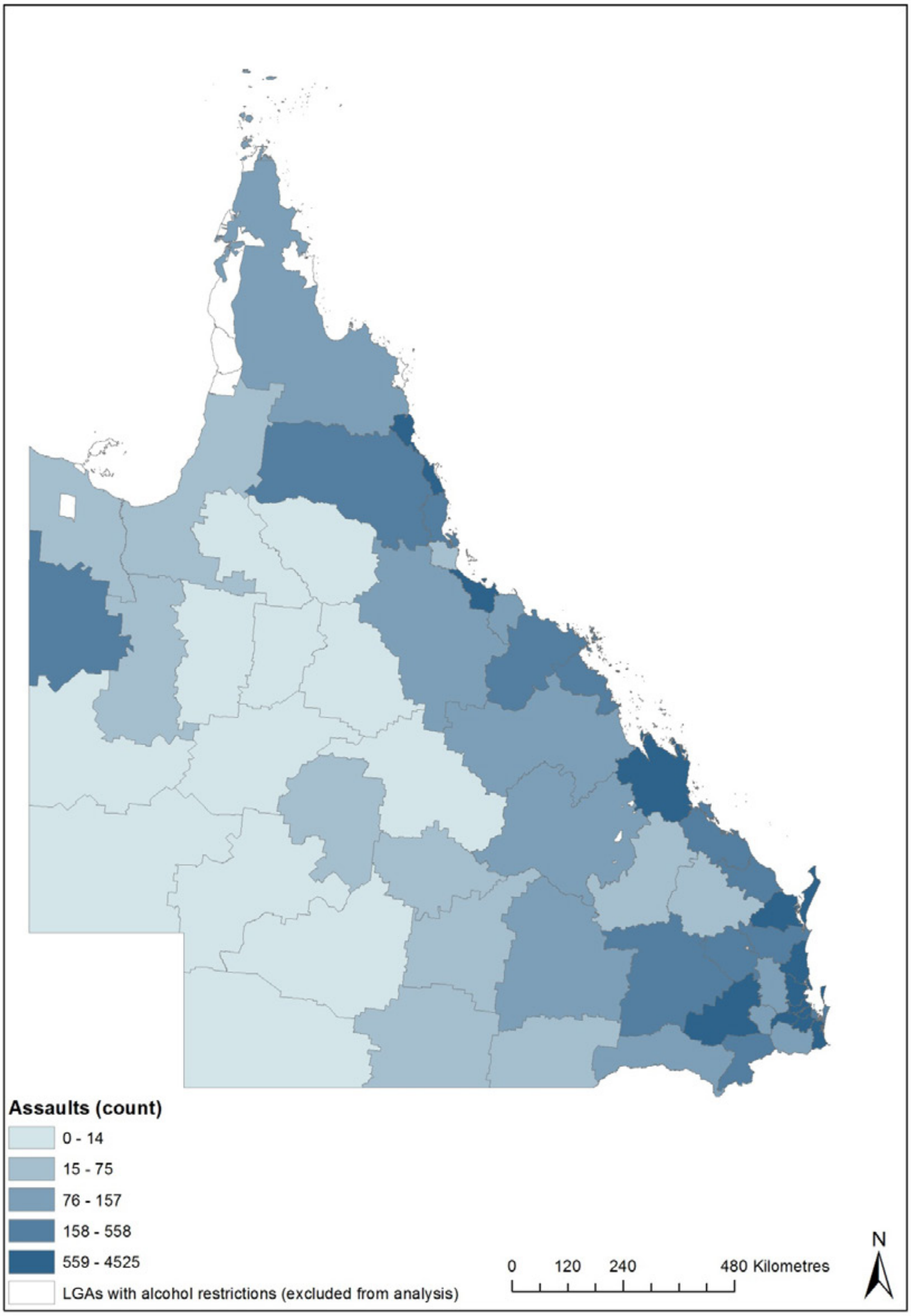
a: Where latitude and longitude coordinates known

b: Where victim age or sex known

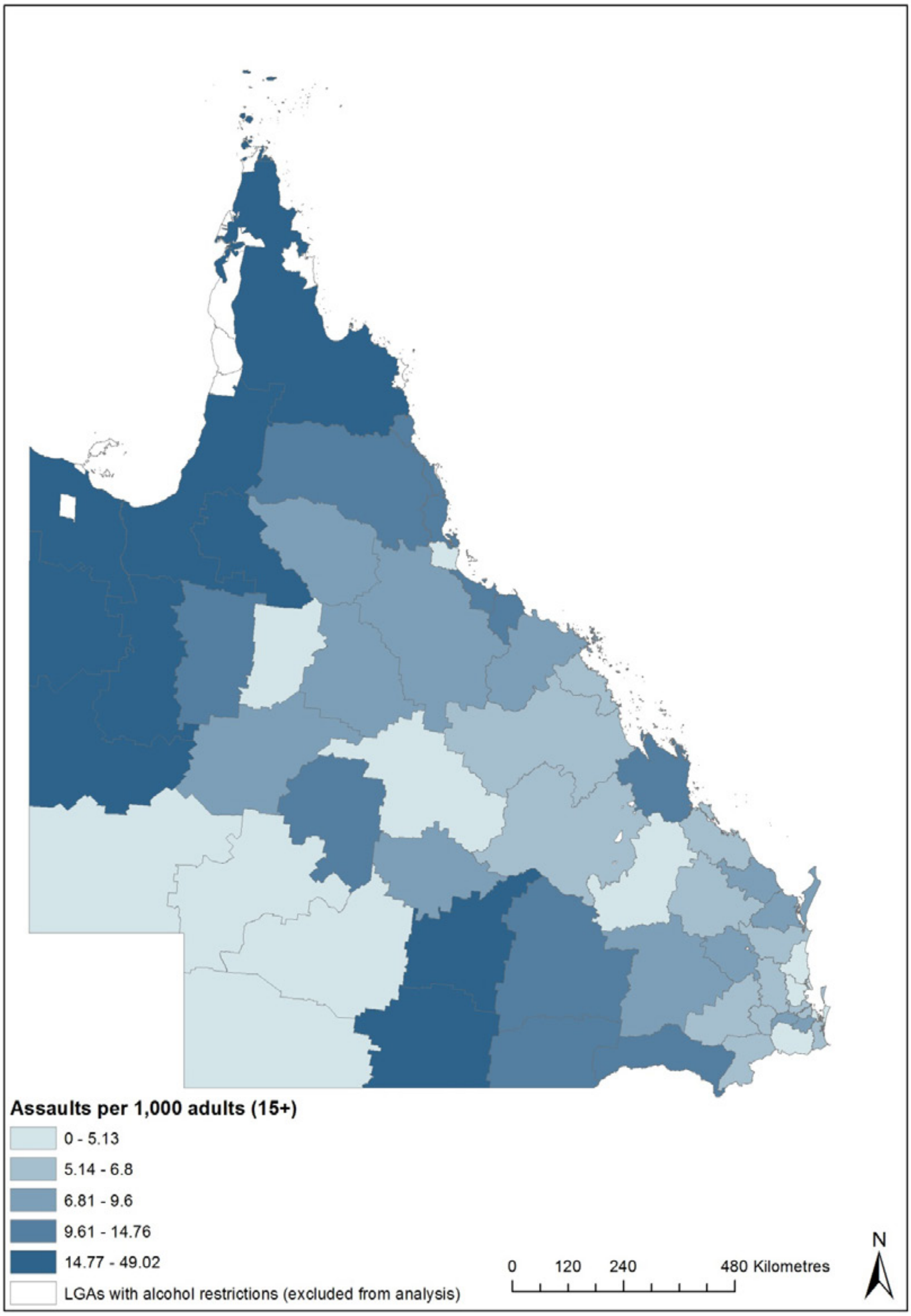
c: Where victim known

d: Where victim known and time of assault known

Map 17: Distribution of assaults by local government area, Queensland 2008–09



Map 18: Distribution of assaults per 1,000 adults (aged 15 years or older) by local government area, Queensland 2008–09



4.2 Queensland: Multivariate model results

Table 4 provides multivariate model results for Queensland assaults by location. The pseudo R squared[10] for all location models was moderate overall, ranging between 34 percent and 45 percent.

Controlling for levels of total alcohol consumption, numbers of restaurants significantly predicted assaults occurring at on-site licensed outlets (IRR=1.004) and in the street (IRR=1.002, p=0.051). In simple terms, there was an estimated 0.4 percent increase in the risk of assault at on-site outlets and a 0.2 percent increase in the risk of assault in the street for every additional restaurant.

Compared with LGAs with the lowest levels of alcohol sales (but greater than zero sales), LGAs in the two highest sales quantiles had significantly higher risk of assault occurring at on-site licensed outlets and in the street. The association between LGAs with the highest volumes of sales (sales group four) and on-site outlet assaults was particularly noteworthy, with the risk estimated to be more than 5.5 times higher than the low-sales reference group (sales group one). Counts of bottleshops, hotels/nightclubs and 'other' outlets did not significantly predict violence occurring at any of the locations examined. The association between community clubs and on-site assaults closely approached significance (IRR=1.016, p=0.055). None of the outlet counts or level of sales variables was significantly associated with assaults occurring at private residences, 'other' places or 'total' assaults.

Table 5 summarises model results for assaults differentiated by sex and age. These models included only assault cases where a victim was indicated and their age and/or sex was known. As indicated for the location models, pseudo R squared was moderately high in most models. Numbers of hotels/nightclubs significantly predicted assaults occurring among child victims aged younger than 15 years (IRR=1.012) and males aged 15–30 years (IRR=1.011). Thus, for every additional hotel/nightclub, the risk of reported assault increased by 1.2 percent among child victims and by 1.1 percent among young male victims. Counts of restaurants had a small but significant effect on the risk of assaults among male victims (IRR=1.001). Higher levels of 'other' liquor licences (eg motels, catering, theatres) were associated with lower risks for assaults among children under the age of 15 years (IRR=0.995), young people (IRR=0.997) and among young males specifically (IRR=0.994). Controlling for numbers of outlets, the risk of assault among female victims was significantly higher among the two upper quantile sales groups (sales group three, IRR=2.087; sales group four, IRR=2.251) compared with LGAs with the lowest sales volumes.

Models for each major type of assault are shown in Table 6. Pseudo R squared exceeded 40 percent in most models. Overall, model results for cases where the victim was aged 15 years or over were similar to models that did not restrict cases by age. Numbers of hotels/nightclubs significantly predicted total common assaults and common assaults occurring among victims aged 15 years or older to the same extent (IRR=1.009). Restaurants were significantly associated with total serious assaults and those that occurred among victims aged 15 years or older (IRR=1.002). Outlets with 'other' licence types were significantly associated with lower risk of total common assaults and common assault among adults (IRR=0.995). Serious assaults (total and for those aged 15 years or older) were significantly predicted by total pure alcohol sales. Compared with LGAs with the lowest levels of alcohol sales, among LGAs in the two highest quantiles, risk of serious assault was more than twice that for the low-sales reference group.

Among the temporal models (Table 7), numbers of restaurants were significantly associated with higher numbers of weekend assaults (IRR=1.002). Other outlets were associated with lower numbers of daytime assaults (IRR=0.996). It is notable that more than half of all licensed 'other' outlets were not indicated as having made alcohol purchases from wholesalers in 2008–09.

Among the range of potential confounders controlled for in all models, all were found to be significant within at least one model. Several variables consistently indicated a relationship with assault counts throughout most models. As expected, residential population size was an important predictor of violence such that as population increased, so too did the number of assaults. SEIFA was also significant across all models, with

10 McFadden's pseudo R squared is an approximation of R squared applied in ordinary least squares regression and its interpretation should be treated with caution (please see http://www.ats.ucla.edu/stat/stata/output/stata_nbreg_output.htm).

higher scores protective for assault risk. For most models, the presence of substantial mining activity was significantly protective against assault, with the lower risk among LGAs with mining versus those without mining ranging from about 27 percent (IRR=0.790) to 87 percent (IRR=0.536).

The proportion of the total population indicated as Indigenous was a strong predictor of assault in most models, including total assaults, with notable exceptions including models for on-site outlet assaults, night-time assaults and assaults on children and young males. The risk of assault tended to increase as the proportion of Indigenous residents increased. When compared with LGAs with the lowest proportions of Indigenous residents (<2 percent), LGAs in the sixth and seventh quantiles had the highest risk of assault (up to 5.4 times the risk). The relationship was, however, not entirely linear, as LGAs falling within the eighth quantile for proportion of Indigenous residents (ie Indigenous residents exceeded 89 percent) often indicated reduced risk of assault (although reaching significance only in two models). For example, compared with the reference group, LGAs in the eighth Indigenous residents quantile indicated a 5.7 times lower risk of night-time assaults (IRR=0.176) and a 12.2 times lower risk for sexual assault (IRR=0.082).[11]

11 Note that LGAs with Indigenous resident proportions falling within the ninth quantile were excluded from analyses as all had alcohol restrictions.

Table 4: Model results for assaults by location, Queensland

Pseudo R^2	0.34			0.45			0.35			0.42			0.44		
	Total assaults			Assaults at on-site outlets			Assaults at private residences			Assaults in the street			Assault at other places		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Outlet type (counts)															
Bottleshops (detached)	1.008	0.992	1.024	0.986	0.961	1.011	1.014	0.993	1.035	1.002	0.985	1.018	1.002	0.988	1.016
Hotels/nightclubs	1.007	0.999	1.014	0.998	0.986	1.010	1.006	0.996	1.016	1.004	0.996	1.012	1.004	0.997	1.010
Restaurants	1.000	0.998	1.002	1.004*	1.002	1.007	0.999	0.996	1.001	1.002+	1.000	1.004	0.999	0.998	1.001
Community clubs	0.991	0.981	1.001	1.016#	1.000	1.033	0.988	0.975	1.001	0.995	0.984	1.005	0.997	0.988	1.006
Other	0.997	0.994	1.001	0.994	0.989	1.000	0.997	0.993	1.002	1.001	0.997	1.004	0.998	0.995	1.001
Total pure alcohol sales quantile (L)															
Sales group 1	(base)			(base)			(base)			(base)			(base)		
Sales group 2	1.064	0.772	1.466	2.132	0.845	5.381	1.052	0.645	1.718	1.616	0.962	2.715	0.742	0.479	1.150
Sales group 3	1.149	0.698	1.891	3.477*	1.014	11.921	1.298	0.629	2.676	2.188*	1.062	4.505	0.756	0.401	1.423
Sales group 4	0.992	0.498	1.974	5.841*	1.226	27.836	1.063	0.401	2.814	2.677*	1.048	6.837	0.560	0.247	1.271
Demographic and socioeconomic variables															
Total population aged 15+ (ERP) (ln)	3.125*	2.576	3.790	2.208*	1.474	3.307	3.132*	2.376	4.129	2.352*	1.844	3.001	3.330*	2.659	4.169
Average male age	0.978	0.897	1.068	0.927	0.749	1.148	0.988	0.859	1.136	0.870*	0.766	0.988	0.971	0.873	1.080
Average female age	0.973	0.904	1.047	0.963	0.809	1.147	0.971	0.866	1.090	1.050	0.944	1.167	0.979	0.893	1.074
Percent males (15+ years)	1.041	0.998	1.085	1.019	0.904	1.149	1.023	0.957	1.094	1.056	0.991	1.125	1.049	0.993	1.109
Population density	0.999	0.998	1.000	1.000	0.998	1.003	0.999	0.997	1.001	1.000	0.998	1.001	1.001	0.999	1.002
SEIFA	0.996*	0.993	0.999	0.994*	0.988	0.999	0.996	0.992	1.001	0.992*	0.988	0.995	0.994*	0.991	0.997
Indigenous population quantile															
0	(base)			(base)			(base)			(base)			(base)		

Table 4: Model results for assaults by location, Queensland cont.

1	1.093	0.833	1.435	1.646	0.924	2.935	1.094	0.729	1.641	0.796	0.565	1.123	1.156	0.870	1.536
2	1.167	0.891	1.529	1.265	0.728	2.199	1.283	0.871	1.891	0.947	0.678	1.324	1.289	0.977	1.701
3	1.421*	1.050	1.923	1.609	0.818	3.165	1.267	0.813	1.974	1.301	0.876	1.933	1.408*	1.015	1.953
4	1.257	0.873	1.809	1.282	0.566	2.899	1.335	0.791	2.253	1.430	0.876	2.333	1.613*	1.070	2.432
5	1.916*	1.392	2.637	1.307	0.676	2.524	2.434*	1.514	3.914	1.362	0.915	2.028	2.072*	1.470	2.921
6	3.037*	2.068	4.459	2.305	0.906	5.866	3.263*	1.800	5.917	2.155*	1.224	3.795	3.976*	2.445	6.464
7	4.677*	2.633	8.306	1.347	0.307	5.907	5.365*	2.124	13.552	2.307	1.001	5.316	5.239*	2.612	10.509
8	1.191	0.253	5.600	0.062	0.002	1.844	1.412	0.127	15.639	0.238	0.035	1.617	0.857	0.160	4.592
Mining															
No	(base)			(base)			(base)			(base)			(base)		
Yes	0.790*	0.638	0.977	0.536*	0.347	0.826	0.790	0.580	1.077	0.892	0.673	1.181	0.762*	0.588	0.988
ARIA															
1	(base)			(base)			(base)			(base)			(base)		
2	0.833	0.583	1.190	1.525	0.860	2.702	0.656	0.420	1.025	1.186	0.830	1.695	1.097	0.830	1.451
3	1.018	0.660	1.568	2.092*	1.115	3.925	0.775	0.454	1.323	1.188	0.802	1.761	1.262	0.911	1.748
4	0.812	0.513	1.286	3.352*	1.611	6.974	0.531*	0.299	0.944	1.309	0.838	2.044	0.925	0.638	1.341
5	1.298	0.759	2.218	5.067*	1.979	12.975	0.946	0.461	1.943	1.797	0.990	3.261	1.341	0.784	2.293
Tourism quantile															
0	(base)			(base)			(base)			(base)			(base)		
1	1.139	0.925	1.403	1.462	0.895	2.388	1.295	0.957	1.752	1.045	0.786	1.389	0.896	0.691	1.163
2	1.230*	1.016	1.488	1.639*	1.134	2.370	1.223	0.939	1.594	1.172	0.934	1.470	1.046	0.868	1.261
3	1.162	0.944	1.431	1.452	0.975	2.163	1.172	0.890	1.543	1.154	0.910	1.462	1.016	0.833	1.240
4	1.143	0.824	1.584	2.461*	1.403	4.317	1.176	0.766	1.806	1.069	0.750	1.523	1.071	0.793	1.447

* p<0.05

+ p=0.051

\# p=0.055

Table 5: Model results for assaults by victim age and sex subpopulation, Queensland[a]

Pseudo R^2	0.38			0.46			0.43			0.37			0.41			0.46		
	Adult (15+ years)			Child (0–14 years)			Male			Female			People aged 15–30 years			Males aged 15–30 years		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Outlet type (counts)																		
Bottleshops (detached)	1.000	0.991	1.010	1.008	0.988	1.029	1.000	0.989	1.011	1.009	0.996	1.022	1.001	0.988	1.013	1.000	0.982	1.018
Hotels/nightclubs	1.003	0.998	1.007	1.012*	1.003	1.022	1.004	0.998	1.009	1.004	0.998	1.010	1.005	1.000	1.011	1.011*	1.003	1.020
Restaurants	1.001	1.000	1.002	0.999	0.997	1.001	1.001*	1.000	1.003	0.999	0.998	1.000	1.001	1.000	1.002	1.002	1.000	1.004
Clubs	0.997	0.991	1.003	0.991	0.979	1.004	0.995	0.988	1.002	0.993	0.985	1.001	0.996	0.988	1.004	0.993	0.982	1.004
Other	0.999	0.997	1.001	0.995*	0.990	1.000	0.998	0.996	1.001	1.000	0.997	1.002	0.997*	0.994	1.000	0.994*	0.990	0.998
Total pure alcohol sales quantile (L)																		
Sales group 1	(base)			(base)			(base)			(base)			(base)			(base)		
Sales group 2	1.190	0.891	1.589	0.830	0.412	1.674	0.890	0.628	1.261	1.293	0.875	1.910	1.116	0.757	1.645	0.957	0.549	1.668
Sales group 3	1.465	0.970	2.213	0.616	0.239	1.590	0.943	0.574	1.550	2.087*	1.189	3.665	1.184	0.679	2.064	0.657	0.299	1.444
Sales group 4	1.425	0.833	2.439	0.479	0.146	1.578	0.851	0.449	1.615	2.251*	1.084	4.672	1.135	0.547	2.356	0.502	0.180	1.404
Demographic and socioeconomic variables																		
Total population aged 15+ (ERP) (ln)	2.861*	2.476	3.305	3.513*	2.538	4.863	2.984*	2.530	3.519	2.570*	2.108	3.131	2.880*	2.356	3.520	3.531*	2.652	4.701
Average male age	0.932*	0.868	1.000	0.963	0.809	1.147	0.999	0.933	1.070	0.979	0.888	1.081	0.875*	0.793	0.965	0.864*	0.754	0.991
Average female age	1.006	0.947	1.067	0.929	0.804	1.073	0.947	0.888	1.011	0.972	0.894	1.056	1.028	0.947	1.116	1.024	0.915	1.147
Percent males (15+ years)	1.061*	1.024	1.100	1.023	0.928	1.127	-			1.019	0.969	1.071	1.087*	1.036	1.140	1.131*	1.055	1.211
Population density	1.000	0.999	1.001	0.998*	0.996	1.000	1.000	0.999	1.001	1.000	0.998	1.001	1.000	0.999	1.001	0.999	0.997	1.001
SEIFA	0.994*	0.992	0.996	0.993*	0.989	0.997	0.995*	0.992	0.997	0.994*	0.992	0.997	0.994*	0.992	0.997	0.996*	0.992	0.999
Indigenous population quantile																		

Table 5: Model results for assaults by victim age and sex subpopulation, Queensland[a] cont.

0	(base)			(base)			(base)			(base)			(base)			(base)		
1	1.072	0.885	1.299	0.802	0.544	1.182	1.133	0.898	1.430	0.941	0.733	1.206	0.978	0.754	1.268	1.059	0.736	1.524
2	1.161	0.965	1.398	0.826	0.551	1.238	1.146	0.917	1.433	1.142	0.894	1.459	0.998	0.777	1.282	0.836	0.586	1.191
3	1.378*	1.105	1.718	0.775	0.479	1.256	1.589*	1.233	2.048	1.095	0.818	1.466	1.101	0.815	1.489	0.986	0.645	1.506
4	1.591*	1.211	2.091	0.667	0.361	1.231	1.496*	1.101	2.033	1.604*	1.113	2.311	1.136	0.783	1.648	0.822	0.488	1.386
5	1.775*	1.420	2.219	1.433	0.865	2.375	1.589*	1.208	2.089	1.965*	1.459	2.646	1.505*	1.115	2.032	1.204	0.788	1.841
6	3.034*	2.207	4.172	1.855	0.878	3.919	2.875*	1.965	4.206	3.246*	2.119	4.972	2.716*	1.783	4.136	1.796	0.981	3.289
7	3.474*	2.173	5.554	1.890	0.645	5.542	2.550*	1.432	4.540	4.897*	2.608	9.196	2.813*	1.492	5.302	1.626	0.662	3.992
8	0.681	0.229	2.029	0.138	0.012	1.547	0.277	0.071	1.077	1.123	0.263	4.797	0.397	0.092	1.722	0.190	0.023	1.587
Mining																		
No	(base)			(base)			(base)			(base)			(base)			(base)		
Yes	0.789*	0.670	0.928	0.597*	0.415	0.858	0.714*	0.589	0.866	0.882	0.706	1.102	0.668*	0.537	0.830	0.565*	0.419	0.763
ARIA																		
1	(base)			(base)			(base)			(base)			(base)			(base)		
2	1.017	0.840	1.231	0.679	0.458	1.007	1.089	0.862	1.374	0.747*	0.583	0.956	0.904	0.697	1.173	0.968	0.668	1.403
3	1.111	0.896	1.378	0.962	0.610	1.517	1.259	0.964	1.643	0.765	0.578	1.014	1.122	0.837	1.504	1.416	0.935	2.147
4	1.092	0.854	1.397	0.441*	0.260	0.747	1.170	0.862	1.588	0.708*	0.515	0.975	1.119	0.803	1.559	1.225	0.763	1.966
5	1.707*	1.215	2.399	0.636	0.290	1.393	1.766*	1.166	2.674	0.873	0.552	1.380	1.541	0.981	2.420	2.323*	1.216	4.437
Tourism quantile																		
0	(base)			(base)			(base)			(base)			(base)			(base)		
1	1.178+	1.000	1.387	0.892	0.602	1.321	1.106	0.900	1.359	1.166	0.935	1.454	1.168	0.932	1.463	1.196	0.866	1.652
2	1.159*	1.023	1.313	1.144	0.877	1.492	1.159	0.995	1.352	1.216*	1.033	1.432	1.199*	1.010	1.423	1.284*	1.006	1.639
3	1.184*	1.039	1.350	0.917	0.684	1.230	1.224*	1.039	1.441	1.084	0.912	1.287	1.147	0.959	1.372	1.240	0.960	1.602
4	1.228*	1.010	1.494	1.001	0.648	1.549	1.265	0.992	1.613	1.180	0.912	1.526	1.344*	1.030	1.754	1.364	0.933	1.993

* $p<0.05$

+ $p=0.05$

a: Where victim known and age or sex reported

Table 6: Model results for assaults by type, Queensland

Pseudo R^2	0.38			0.44			0.44			0.42			0.47			0.45		
	Serious			Sexual			Common			Serious 15+ yearsa			Sexual 15+ yearsa			Common 15+ years[a]		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Outlet type (counts)																		
Bottleshops (detached)	1.001	0.989	1.012	0.998	0.977	1.020	1.005	0.991	1.019	0.996	0.983	1.009	0.992	0.962	1.024	1.009	0.994	1.025
Hotels/nightclubs	1.002	0.997	1.007	1.000	0.990	1.010	1.009*	1.003	1.016	1.000	0.994	1.006	0.988	0.974	1.003	1.009*	1.001	1.016
Restaurants	1.002*	1.001	1.003	0.998	0.996	1.000	1.000	0.998	1.001	1.002*	1.001	1.003	0.998	0.995	1.001	1.000	0.998	1.001
Clubs	0.993	0.986	1.000	1.007	0.993	1.021	0.993	0.985	1.002	0.996	0.988	1.005	1.017	0.997	1.038	0.995	0.985	1.004
Other	1.000	0.998	1.003	1.000	0.995	1.005	0.995*	0.992	0.998	1.001	0.998	1.004	1.001	0.994	1.008	0.995*	0.991	0.998
Total pure alcohol sales quantile (L)																		
Sales group 1	(base)			(base)			(base)			(base)			(base)			(base)		
Sales group 2	1.183	0.825	1.696	0.416*	0.216	0.803	1.219	0.785	1.891	1.304	0.869	1.956	0.379*	0.149	0.966	1.170	0.735	1.862
Sales group 3	2.145*	1.296	3.551	0.667	0.259	1.716	0.743	0.395	1.397	2.269*	1.289	3.993	0.955	0.253	3.605	0.866	0.442	1.698
Sales group 4	2.610*	1.358	5.017	0.618	0.180	2.119	0.484	0.214	1.098	2.804*	1.347	5.837	0.853	0.146	4.993	0.670	0.277	1.620
Demographic and socioeconomic variables																		
Total population aged 15+ (ERP) (ln)	2.459*	2.071	2.920	2.675*	1.906	3.756	3.891*	3.101	4.884	2.451*	2.017	2.977	2.519*	1.560	4.068	3.355*	2.623	4.292
Average male age	0.904*	0.827	0.989	1.074	0.901	1.281	0.941	0.847	1.045	0.899*	0.813	0.994	0.931	0.720	1.203	0.930	0.828	1.045
Average female age	1.050	0.974	1.132	0.852*	0.733	0.989	0.968	0.886	1.058	1.055	0.969	1.147	0.934	0.750	1.164	0.988	0.896	1.090
Percent males (15+ years)	1.031	0.984	1.079	0.944	0.860	1.036	1.101*	1.042	1.163	1.055*	1.003	1.109	0.994	0.878	1.125	1.104*	1.042	1.170
Population density	1.000	0.999	1.001	1.001	0.999	1.003	0.999	0.998	1.000	1.000	0.999	1.002	1.003*	1.000	1.006	0.999	0.998	1.000
SEIFA	0.993*	0.991	0.996	0.992*	0.988	0.997	0.994*	0.991	0.997	0.993*	0.991	0.996	0.991*	0.984	0.997	0.995*	0.992	0.998
Indigenous population quantile																		
0	(base)			(base)			(base)			(base)			(base)			(base)		

Table 6: Model results for assaults by type, Queensland cont.

1	1.012	0.799	1.282	0.930	0.617	1.401	0.986	0.742	1.312	1.035	0.797	1.345	0.912	0.481	1.730	1.116	0.810	1.538
2	1.145	0.906	1.446	1.043	0.696	1.563	1.045	0.794	1.375	1.131	0.876	1.460	1.329	0.723	2.445	1.110	0.818	1.506
3	1.415*	1.076	1.861	0.951	0.582	1.554	1.120	0.806	1.555	1.383*	1.022	1.873	1.257	0.598	2.642	1.296	0.898	1.869
4	1.836*	1.303	2.585	1.153	0.621	2.139	0.943	0.628	1.415	1.916*	1.315	2.793	1.436	0.561	3.674	1.172	0.751	1.831
5	1.627*	1.227	2.159	1.649*	1.004	2.709	1.725*	1.237	2.406	1.567*	1.151	2.131	2.067+	1.001	4.267	1.956*	1.355	2.823
6	2.883*	1.920	4.331	2.179*	1.083	4.387	2.718*	1.701	4.345	2.831*	1.808	4.432	2.373	0.846	6.654	3.498*	2.111	5.797
7	4.116*	2.279	7.435	3.067*	1.109	8.479	2.388*	1.193	4.777	3.678*	1.904	7.104	2.843	0.622	13.004	2.825*	1.331	5.994
8	0.525	0.134	2.061	0.082*	0.007	0.986	0.509	0.102	2.530	0.641	0.139	2.946	0.051	0.001	1.984	0.737	0.126	4.320
Mining																		
No	(base)			(base)			(base)			(base)			(base)			(base)		
Yes	0.950	0.776	1.163	0.734	0.501	1.077	0.577*	0.453	0.735	0.978	0.781	1.224	0.667	0.383	1.161	0.613*	0.471	0.796
ARIA																		
1	(base)			(base)			(base)			(base)			(base)			(base)		
2	0.949	0.748	1.204	1.217	0.809	1.829	0.793	0.599	1.051	1.020	0.784	1.326	1.481	0.801	2.739	0.974	0.709	1.339
3	0.859	0.657	1.122	1.253	0.777	2.020	1.289	0.937	1.774	0.910	0.676	1.224	1.499	0.737	3.047	1.465*	1.026	2.092
4	0.842	0.619	1.145	1.124	0.655	1.930	0.979	0.683	1.403	0.944	0.672	1.327	1.673	0.755	3.705	1.293	0.864	1.934
5	1.206	0.786	1.850	0.807	0.367	1.775	2.127*	1.289	3.510	1.359	0.844	2.189	1.447	0.474	4.414	2.323*	1.350	3.999
Tourism quantile																		
0	(base)			(base)			(base)			(base)			(base)			(base)		
1	1.226*	1.004	1.498	1.098	0.738	1.634	1.003	0.780	1.291	1.185	0.946	1.485	1.442	0.828	2.514	1.060	0.803	1.398
2	1.138	0.974	1.330	1.034	0.784	1.365	1.254*	1.043	1.509	1.087	0.914	1.293	0.890	0.584	1.356	1.288*	1.050	1.579
3	1.227*	1.040	1.447	0.888	0.661	1.193	1.160	0.957	1.406	1.193	0.993	1.435	0.912	0.598	1.391	1.200	0.972	1.482
4	1.012	0.790	1.295	1.396	0.889	2.191	1.465*	1.100	1.950	1.041	0.792	1.369	2.030*	1.049	3.929	1.386*	1.012	1.899

* $p<0.05$

+ $p=0.05$

a: Where victim known and aged 15 years or older

Table 7: Model results for assaults by time of day and weekend, Queensland[a]									
Pseudo R^2	0.41			0.41			0.43		
	Night-time assaults			Daytime assaults			Weekend		
	IRR	95% CI		IRR	95% CI		IRR	95% CI	
Outlet type (counts)									
Bottleshops (detached)	0.995	0.981	1.009	1.010	0.996	1.024	0.995	0.983	1.007
Hotels/nightclubs	1.006	0.999	1.013	1.006	1.000	1.013	1.005	0.999	1.011
Restaurants	1.001	1.000	1.003	0.999	0.998	1.000	1.002*	1.001	1.003
Clubs	0.997	0.988	1.006	0.994	0.986	1.003	0.999	0.991	1.007
Other	0.998	0.994	1.001	0.996*	0.993	0.999	0.998	0.995	1.000
Total pure alcohol sales quantile (L)									
Sales group 1	(base)			(base)			(base)		
Sales group 2	1.561	0.971	2.510	0.828	0.548	1.251	1.316	0.904	1.917
Sales group 3	1.191	0.624	2.273	0.988	0.548	1.782	1.179	0.693	2.007
Sales group 4	0.928	0.404	2.131	0.952	0.444	2.039	1.181	0.589	2.367
Demographic and socioeconomic variables									
Total population aged 15+ (ERP) (ln)	3.189*	2.552	3.985	3.011*	2.450	3.700	2.990*	2.471	3.617
Average male age	0.841*	0.752	0.942	0.958	0.865	1.060	0.899*	0.818	0.989
Average female age	1.040	0.948	1.140	0.989	0.906	1.079	1.003	0.927	1.085
Percent males (15+ years)	1.104*	1.041	1.171	1.043	0.989	1.099	1.102*	1.051	1.156
Population density	0.999	0.998	1.001	1.000	0.999	1.001	0.999	0.998	1.000
SEIFA	0.993*	0.990	0.996	0.992*	0.990	0.995	0.994*	0.992	0.997
Indigenous population quantile									
0	(base)			(base)			(base)		
1	0.779	0.581	1.045	1.116	0.857	1.454	0.974	0.755	1.256
2	0.812	0.607	1.085	1.187	0.914	1.540	0.963	0.754	1.230
3	0.831	0.589	1.171	1.416*	1.042	1.926	1.231	0.918	1.650
4	0.710	0.462	1.092	1.536*	1.044	2.261	1.111	0.776	1.591
5	1.082	0.767	1.527	2.290*	1.651	3.175	1.260	0.940	1.689
6	1.212	0.730	2.013	4.628*	2.919	7.339	1.960*	1.295	2.967
7	1.058	0.497	2.255	5.212*	2.692	10.088	1.761	0.950	3.263
8	0.176*	0.033	0.950	0.504	0.105	2.422	0.376	0.091	1.558
Mining									
No	(base)			(base)			(base)		
Yes	0.650*	0.510	0.828	0.760*	0.595	0.970	0.616*	0.501	0.757
ARIA									
1	(base)			(base)			(base)		
2	0.815	0.605	1.098	1.171	0.904	1.515	0.997	0.769	1.291
3	0.999	0.713	1.399	1.380*	1.026	1.856	1.198	0.895	1.603
4	0.831	0.568	1.215	0.944	0.672	1.326	1.195	0.859	1.662

Table 7: Model results for assaults by time of day and weekend, Queensland[a] cont.

5	1.750*	1.033	2.964	1.172	0.717	1.918	2.252*	1.445	3.508
Tourism quantile									
0	(base)			(base)			(base)		
1	1.255	0.974	1.617	0.871	0.683	1.111	1.192	0.960	1.482
2	1.126	0.925	1.371	1.066	0.898	1.267	1.173	0.991	1.389
3	1.234*	1.004	1.516	0.936	0.780	1.123	1.228*	1.027	1.468
4	1.454*	1.070	1.976	0.992	0.752	1.309	1.212	0.931	1.577

* p<0.05

a: Where victim known

4.3 Western Australia: Descriptive results

This section describes the basic characteristics of the WA liquor outlet and assault datasets.

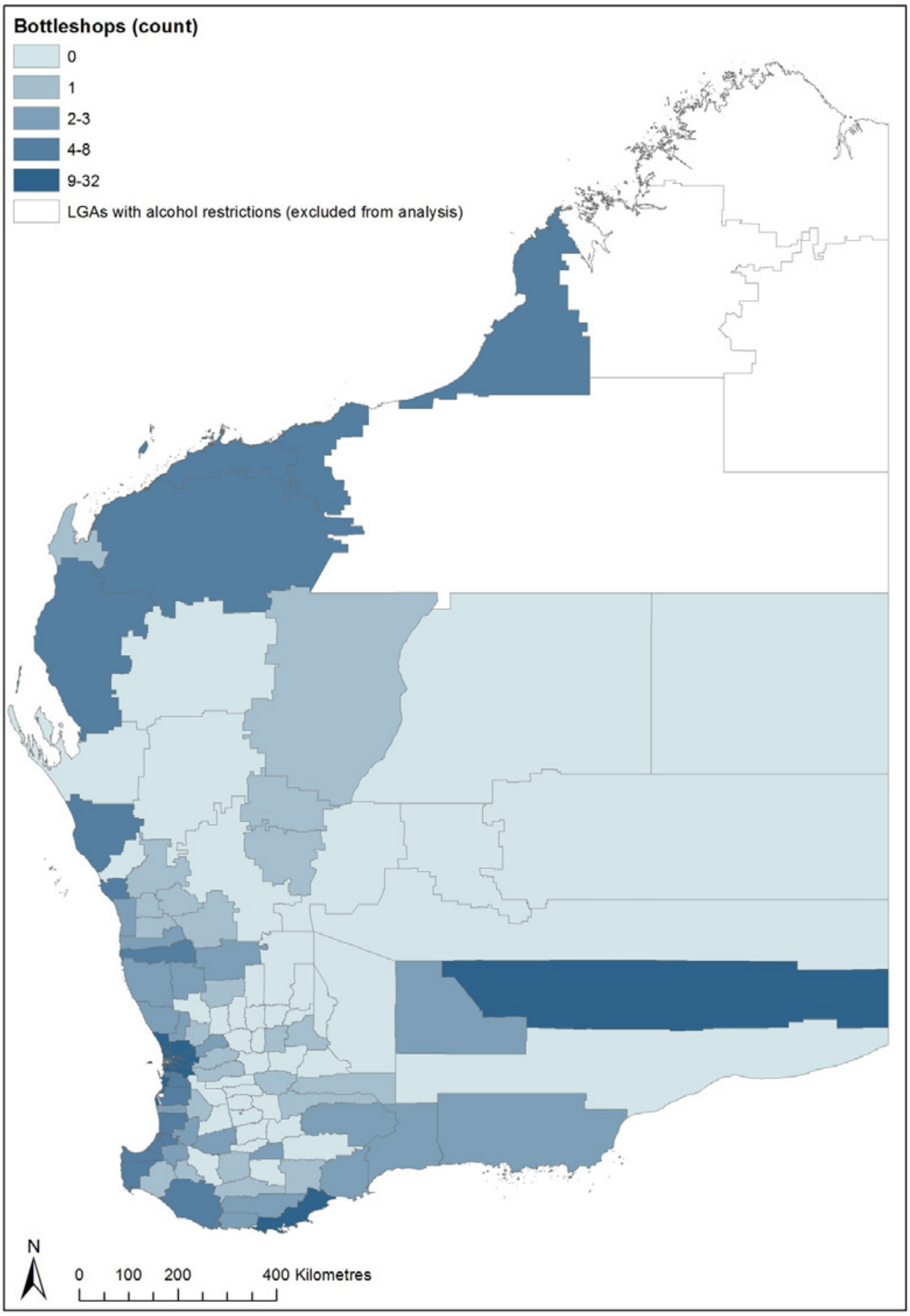
Liquor outlets

There were more than 2,800 licensed outlets in Western Australia in 2008–09. Table 8 lists numbers of outlets by outlet type and shows that the majority of outlets in Western Australia sell alcohol primarily for on-site consumption. Maps 19 to 23 show the distribution of WA alcohol outlets by type. As would be expected, the number of outlets is highest in the more populated LGAs along the coast and inland at Kalgoorlie. This pattern is reversed when taking the estimated residential adult population into account (Map 24), with the highest number of alcohol outlets per 1,000 adults occurring in the more remote and less-populated inland LGAs.

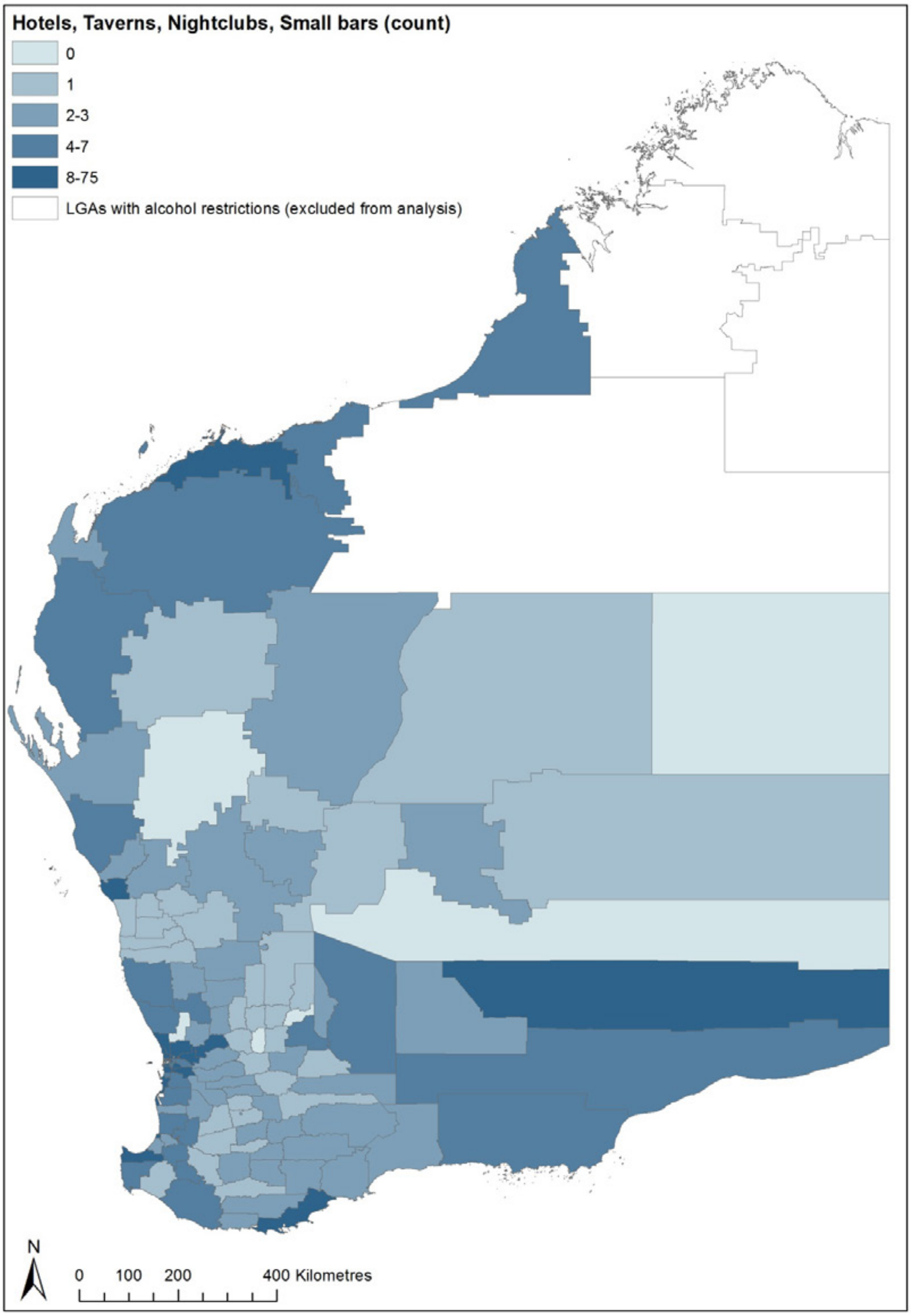
Table 8: Number of outlets by type, Western Australia 2008–09

Outlet type	n	%
Bottleshop	506	18
Hotel/tavern/small bar/nightclub	730	26
Restaurant	763	27
Community club	357	13
Other	501	18
Total	2,857	100
Outlet type grouping	**n**	**%**
On-site outlets	2,351	82
Off-site outlets	506	18
Total	2,857	100

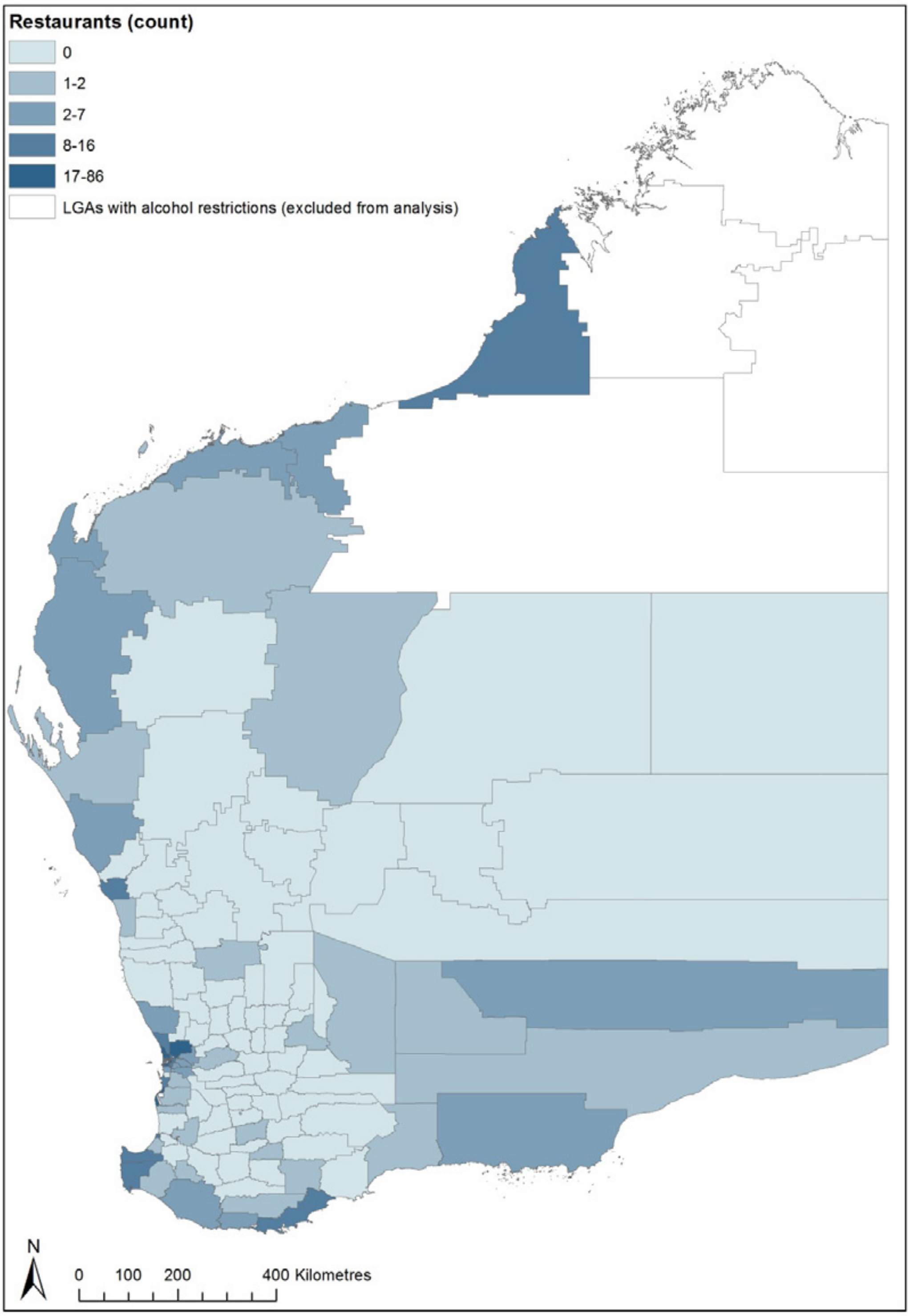
Map 19: Distribution of bottleshops (off-site) by local government area, Western Australia 2008–09



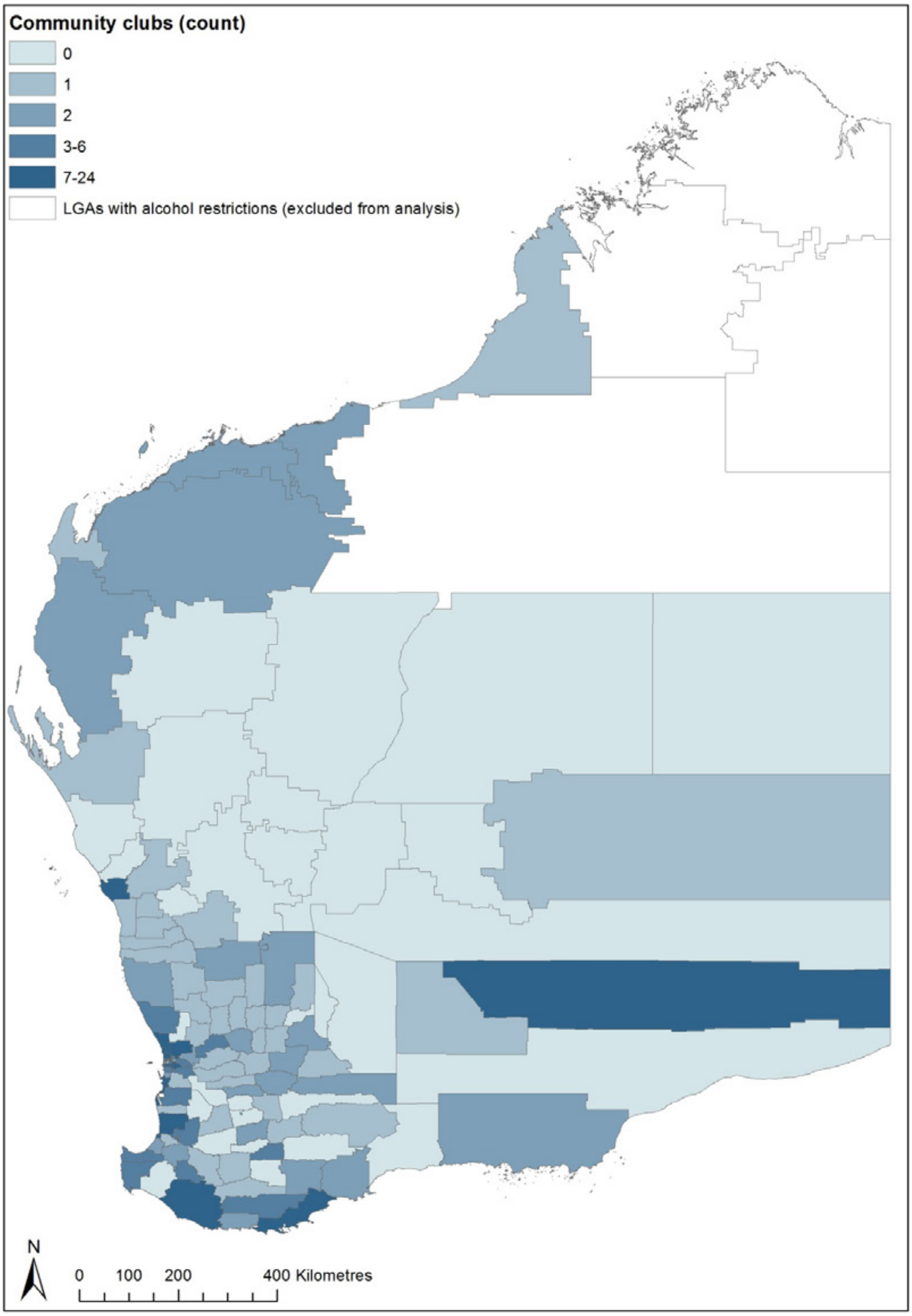
Map 20: Distribution of hotels/taverns, nightclubs and small bars by local government area, Western Australia 2008–09



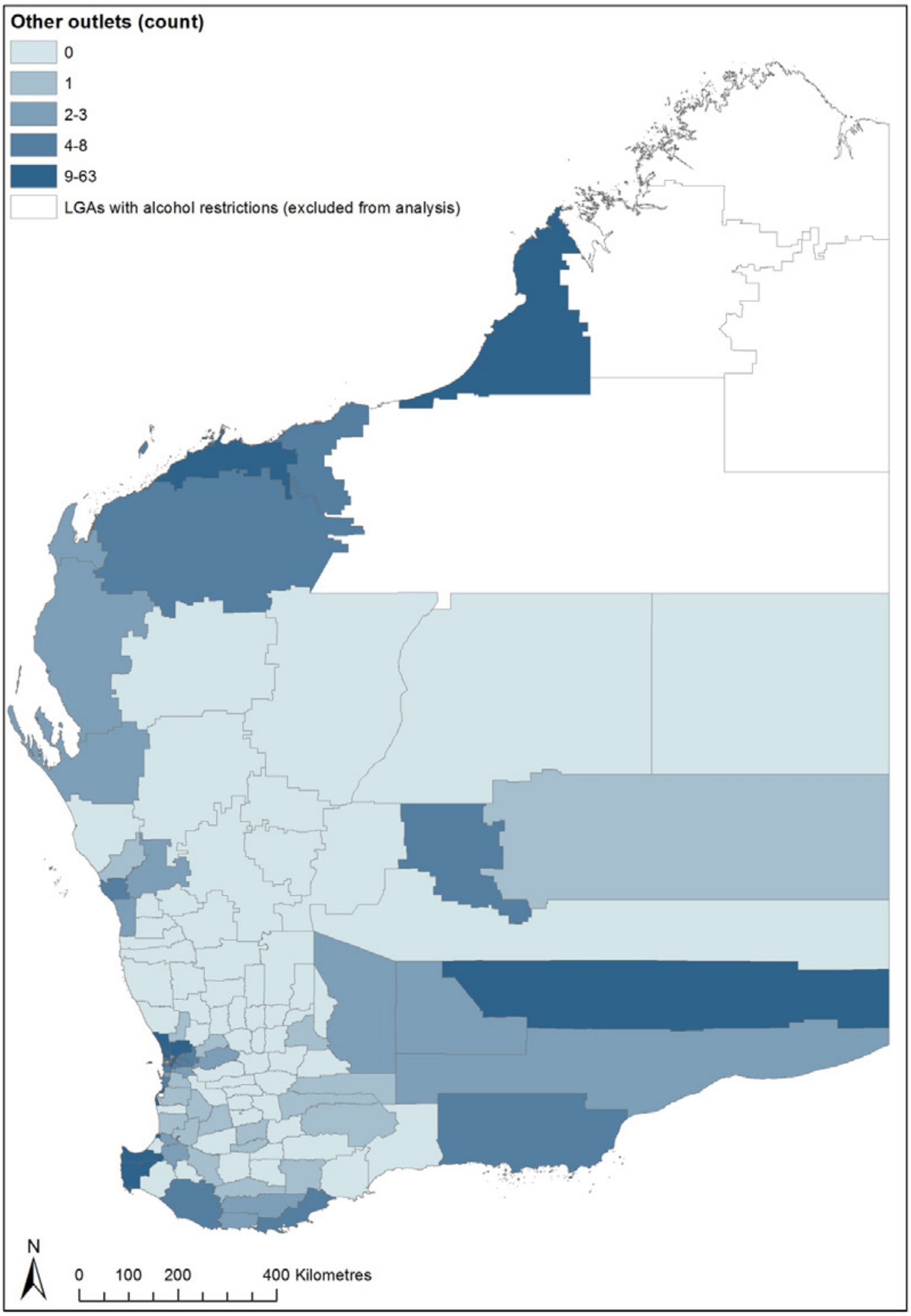
Map 21: Distribution of restaurants by local government area, Western Australia 2008–09



Map 22: Distribution of community clubs by local government area, Western Australia 2008–09



Map 23: Distribution of ‘other’ outlets by local government area, Western Australia 2008–09



Map 24: Distribution of all alcohol outlets per 1,000 adults (aged 15 years or older) by local government area, Western Australia 2008–09

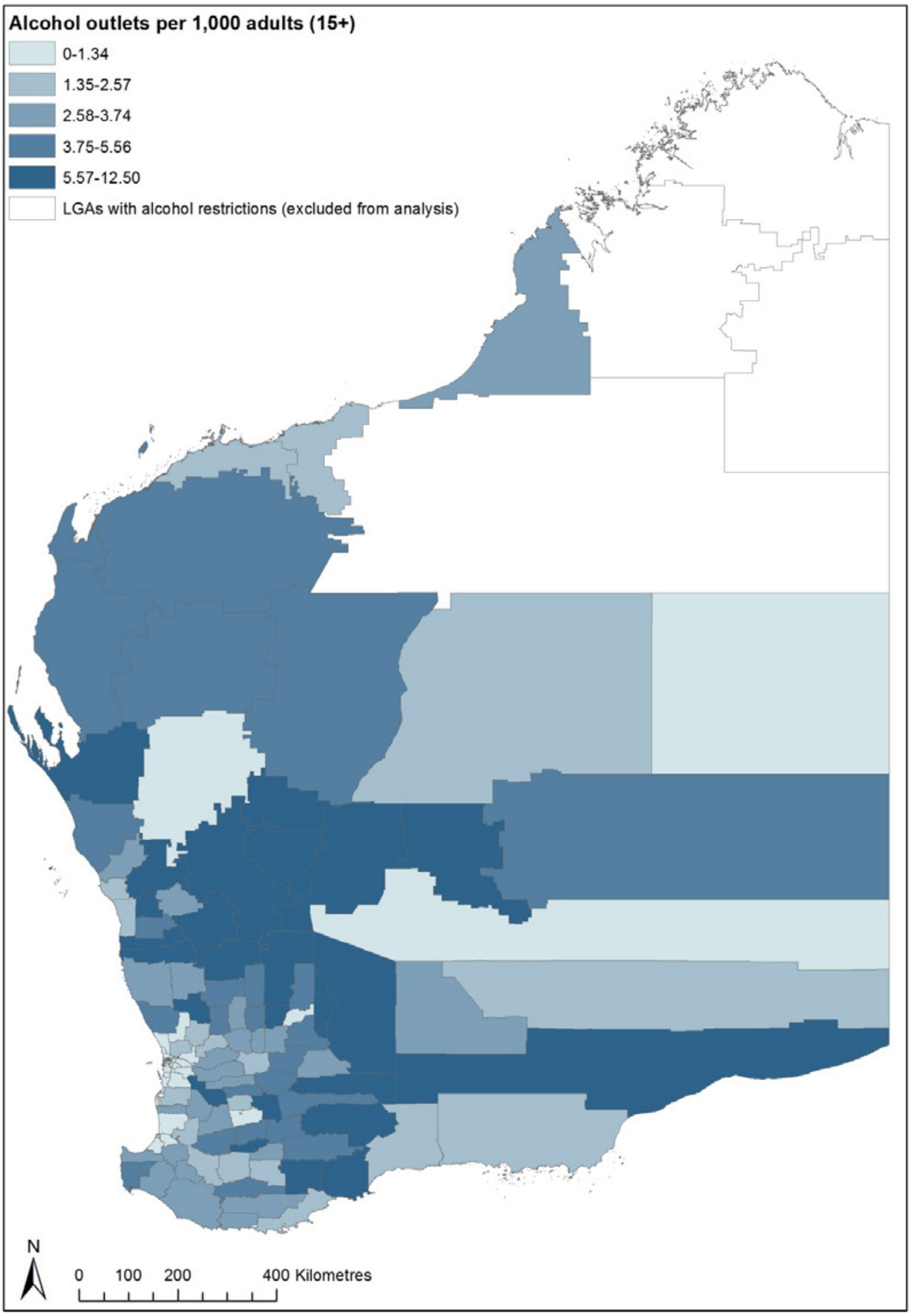


Table 9 provides summary statistics by beverage type for the whole of Western Australia, and Maps 25 and 26 show the distribution of total pure alcohol sales volumes by LGA and per capita alcohol consumption for those aged 15 years or older by LGA, respectively.[12] The distribution of total pure alcohol volume is as expected, with the highest volumes purchased among the most populated coastal LGAs and inland at Kalgoorlie.

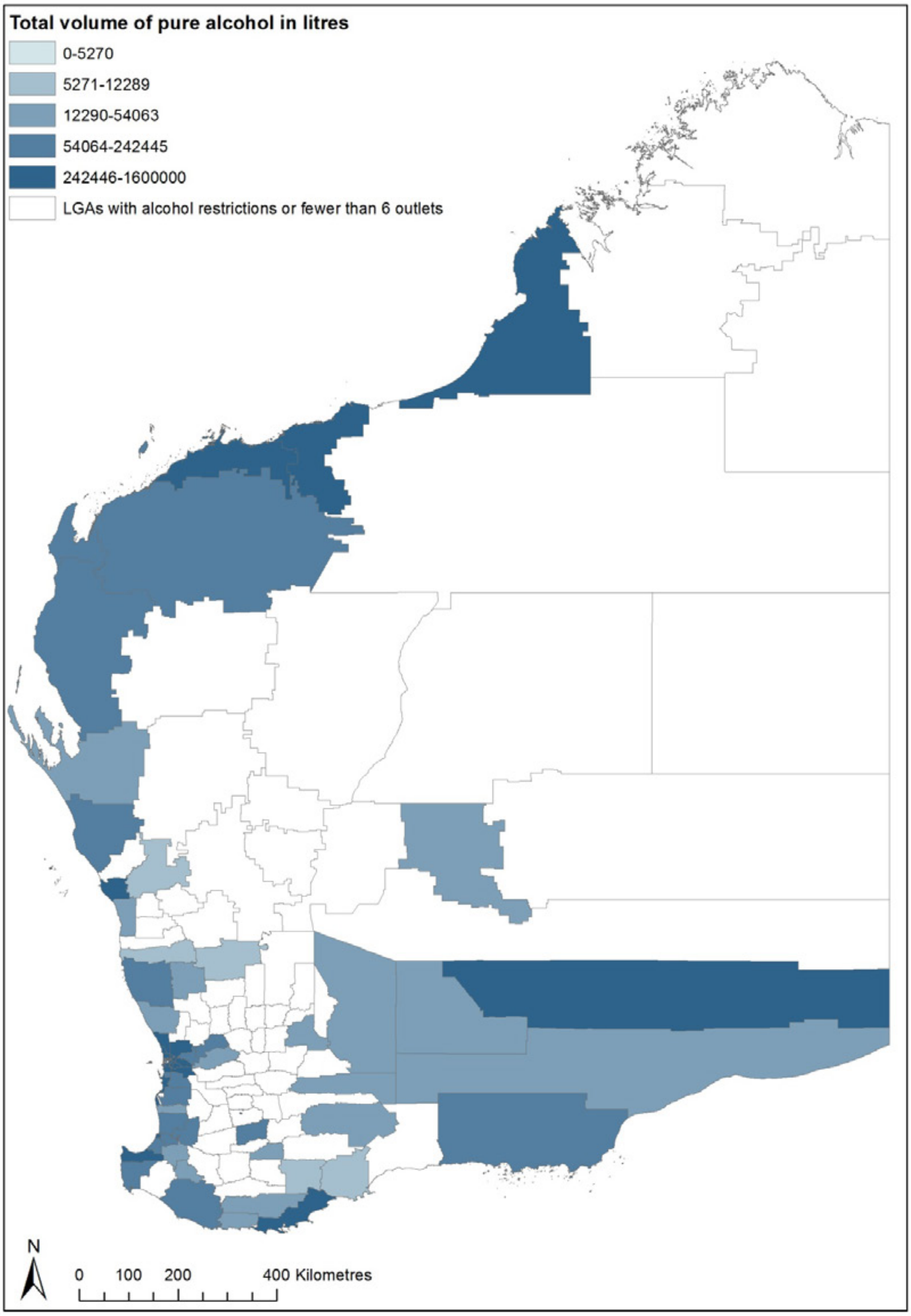
Table 9: Mean volumes of pure alcohol purchased per LGA by beverage type, Western Australia 2008–09 (litres)

Beverage type	Mean (L)	Std Dev.
High-alcohol beer	56,014	98,422
Low-alcohol beer	11,868	19,806
Wine[a]	48,476	102,532
Spirits	28,424	52,808
Total volume	144,764	266,475

a: Includes small volumes of low-alcohol content wine and cider

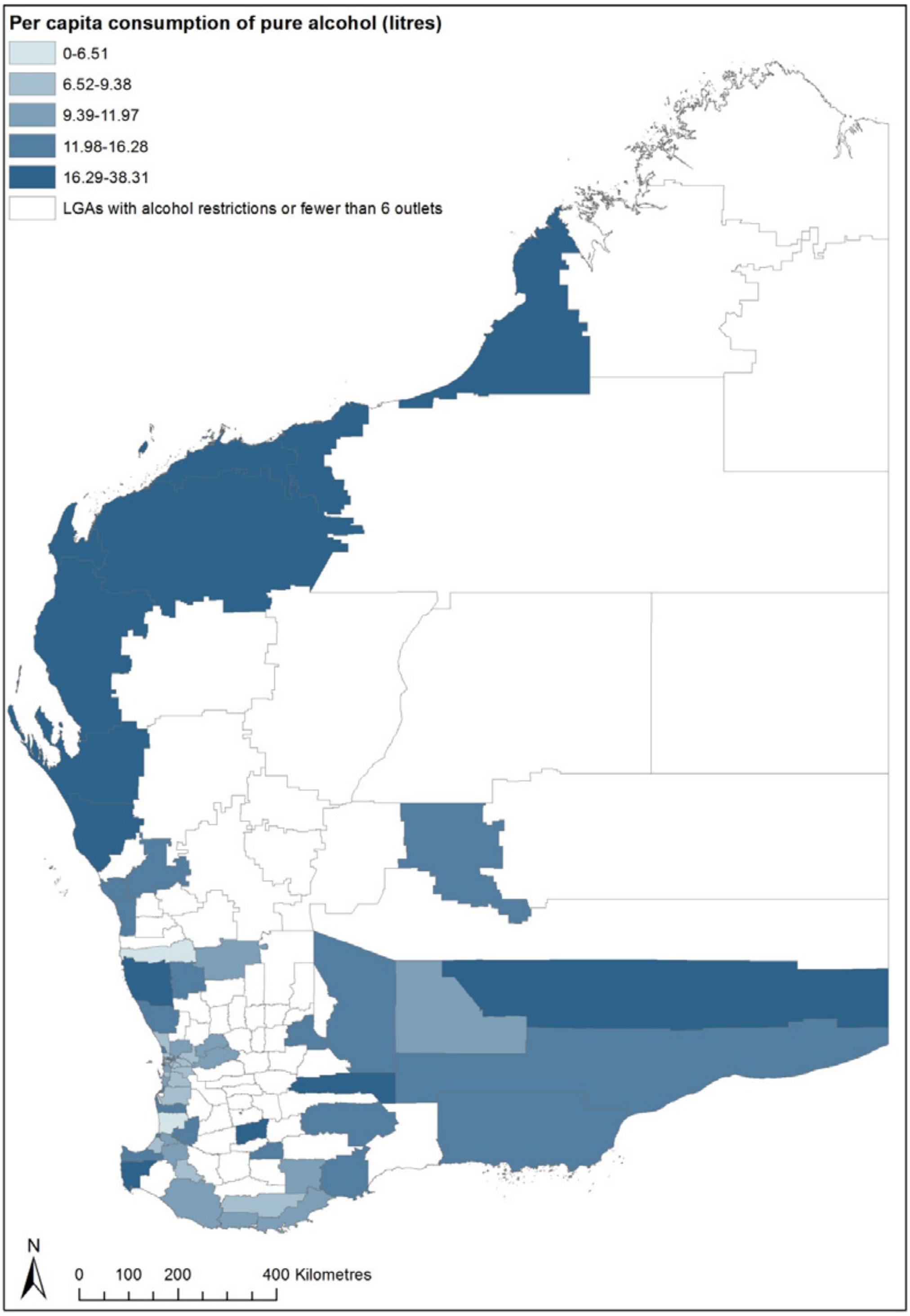
12 LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality.

Map 25: Distribution of pure alcohol sales by local government area, Western Australia 2008–09 (litres)



Note: In addition to restricted areas, LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality

Map 26: Per capita consumption of pure alcohol by local government area, Western Australia 2008–09 (litres)



Note: In addition to restricted areas, LGAs with fewer than six outlets have been masked for the purposes of maintaining confidentiality

Assault offences reported to police

There were more than 26,500 assault offences reported to police that occurred in Western Australia in 2008–09, which is about 15.2 assaults per 1,000 persons aged 15 years and older. Table 10 shows frequencies of assault by location, victim demographics, assault type and time of day. Only 6.4 percent of assaults occurred at on-site licensed premises, while 46.5 percent occurred at private residences. Among assaults where the victim's details were completed, some 29 percent were classified as domestic assaults. There were similar numbers of assaults committed against male and female victims and the majority was committed against adults (78%).

Map 27 shows the distribution of numbers of assaults among WA LGAs in 2008–09. Numbers of assaults were highest in the more populated LGAs; however, the rate of assault per 1,000 adults (Map 28) was highest in the more remote areas.

Table 10: Numbers of assaults and mean number of assaults per local government area by category, Western Australia 2008–09

	Total (n) (all LGAs)	Mean (across LGAs)	Std dev. (across LGAs)
Total assaults[a]	26,536	191	320
Location			
On-site	1,693	12	29
Private residence	12,334	89	155
Street	5,289	38	72
Other	7,220	52	90
Victim age and sex[b]			
Male	11,574	83	147
Female	11,147	80	130
Adult (15+ years)	20,717	149	249
Child (0–14 years)	2,312	17	30
Young (15–30 years)	11,300	81	138
Young male (15–30 years)	5,568	40	75
Assault type[c]			
Non-domestic	13,742	99	176
Domestic	7,750	56	93
Murder/manslaughter	56	<1	<1
Sexual	1,231	9	15
Time of day[d]			
Night time	7,694	55	95
Day time	10,366	75	133
Weekend	13,536	97	164

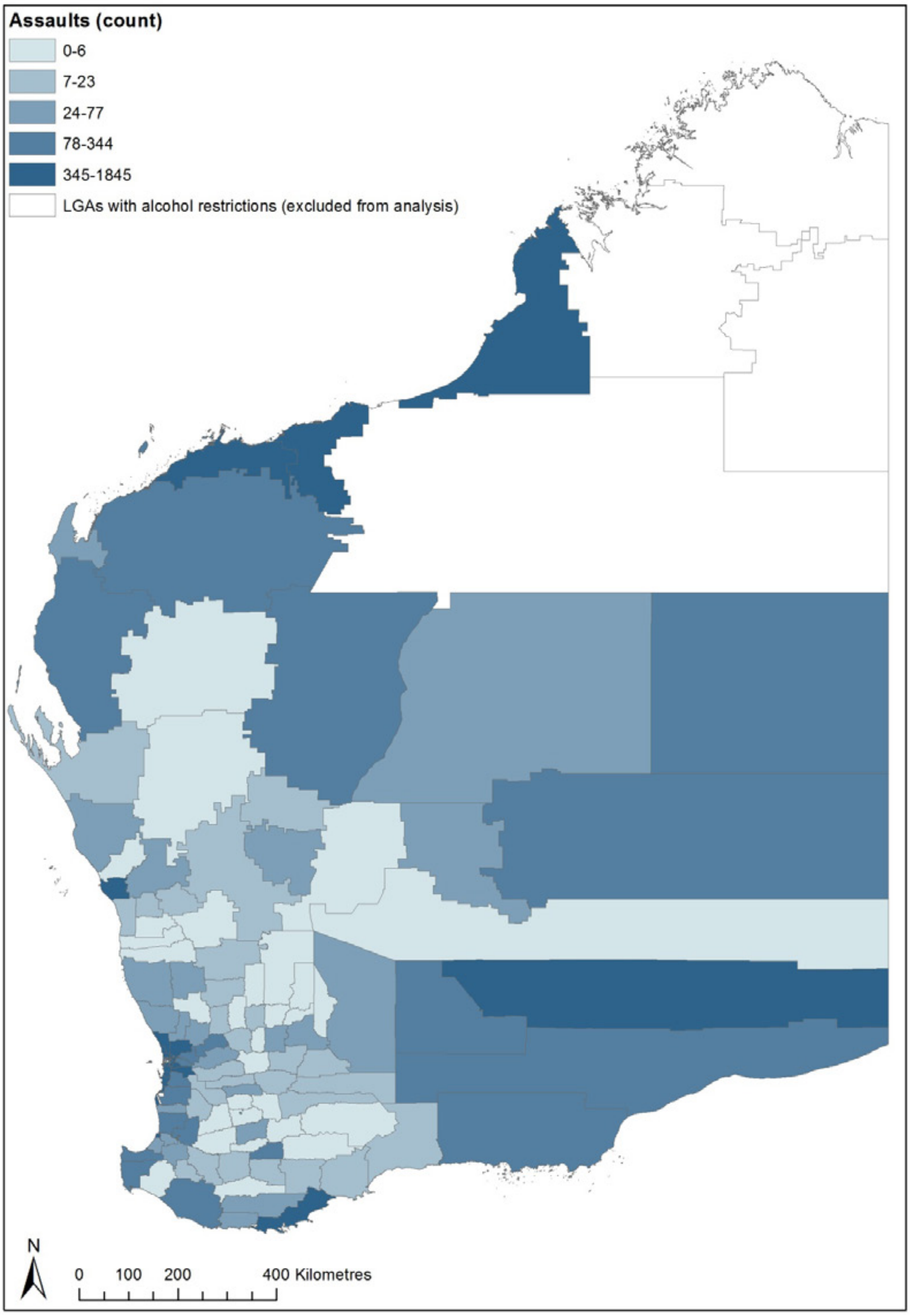
a: Where location known

b: Where victim age or sex known

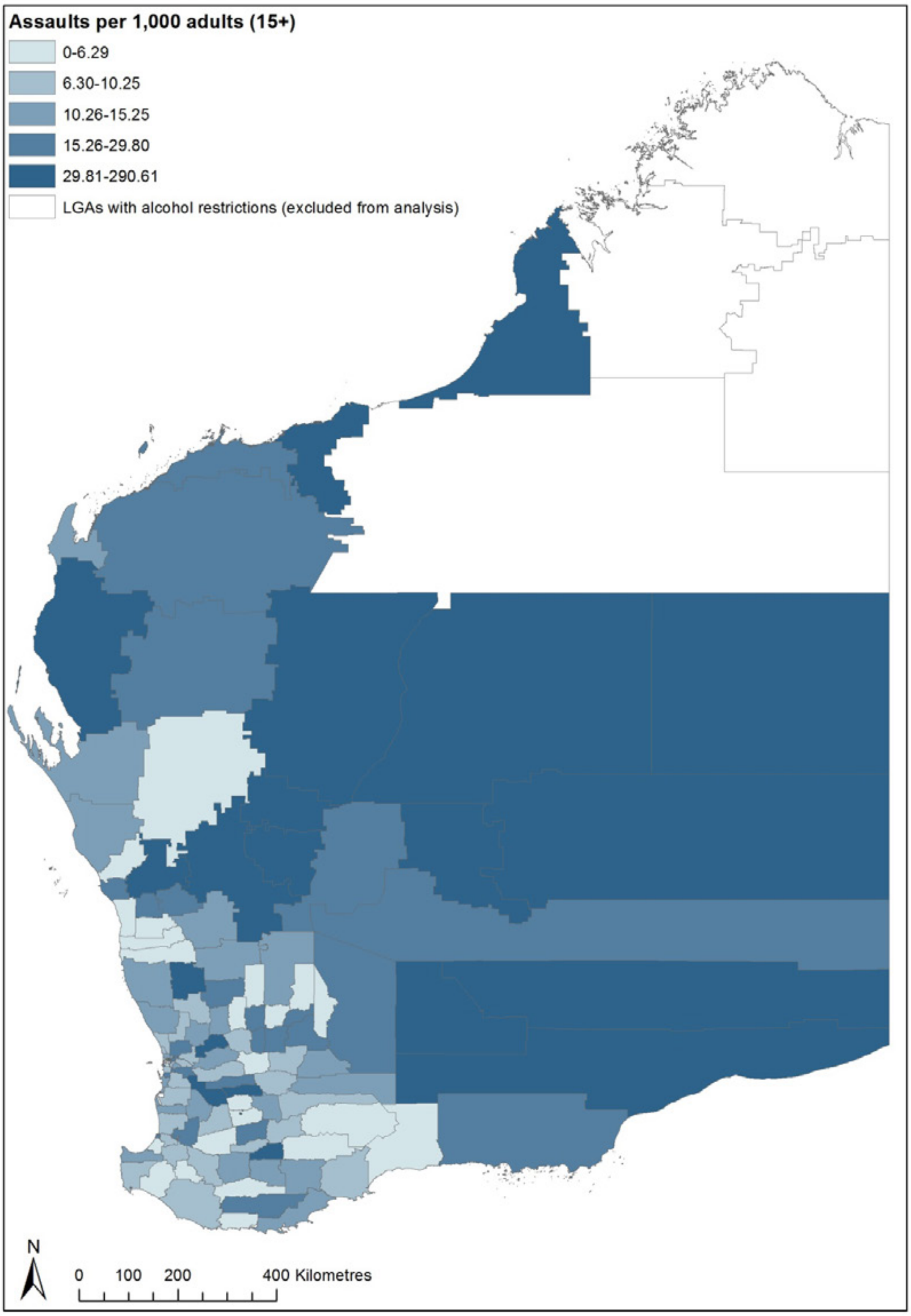
c: Where victim known

d: Where victim known and time of assault known

Map 27: Distribution of assaults by local government area, Western Australia 2008–09



Map 28: Distribution of assaults per 1,000 adults (aged 15 years or older) by local government area, Western Australia 2008–09



4.4 Western Australia: Multivariate model results

Tables 11 to 14 provide multivariate model results for WA assaults by location, age and sex, type of offence and time of day respectively. The pseudo R squared was relatively modest overall, ranging from 23 percent to 36 percent.

The effect of alcohol sales and outlet numbers for on-site and off-site outlets was remarkably consistent across the various models, with off-site alcohol sales and on-site outlet counts significantly predicting assaults for most models.

Off-site alcohol sales predicted total assaults (IRR=1.06), and all other dependent assault variables tested with the exception of murder/manslaughter and assaults occurring at on-site outlets (including a combination of restaurants, hotels/taverns, nightclubs). Notably, the IRR for off-site alcohol sales was largest for assaults occurring in the street (IRR=1.12). In simple terms, then, overall there was an estimated 12 percent increase in the risk of assault in the street for every additional off-site outlet that increased alcohol sales within an LGA by 1 litre per outlet per adult aged 15 years or older. The change in risk due to a new outlet occurring in a particular region (ie postcode) will depend on both the number of outlets and the number of adults residing in that postcode. Moreover, it should be noted that an outlet may bring about a change in sales per person per outlet that is less than a 1 litre increase (ie a fraction of 1 litre) in total sales for that postcode and the change in estimated risk will be commensurate.

When assaults occurring specifically at hotels/taverns were examined (see Appendix E), the risks for off-site outlet alcohol sales approached significance (IRR=1.07, p=0.07) and the number of on-site outlets was a significant predictor (IRR=1.02, p<0.001). When assaults specific to restaurant locations were selected (see Appendix E), numbers of both on-site outlets (IRR=1.04, p<0.001) and off-site outlets (IRR=1.11, p<0.011) were found to be significant predictors.

Counts of on-site outlets significantly predicted assaults in most models tested including total assaults (IRR=1.02); overall, the risk of assault ranged from 1.01 to 1.03. Counts of off-site outlets and sales from on-site outlets showed no significant effects in any of the models tested. An unexpected protective effect for assaults occurring among people aged 15–30 years was indicated for on-site outlets (IRR=0.88, p<0.05) but was not apparent (or significant) when examined among young males (IRR=0.98, ns).

Of the demographic variables entered, population size, average male age, proportion of the population that is male and SEIFA were significant predictors in most models. The presence of mining activity predicted higher levels of reported violence in several models including total assaults (IRR=1.42). With the exception of murder/manslaughter and assaults that occurred at on-site outlets, all models tested indicated that LGAs with higher proportions of Indigenous residents indicated greater risk of assaults report to police compared with LGAs with low proportions of Indigenous residents.

Overall, ARIA and tourism indicators were not particularly important predictors of assault. It was interesting to note, however, that LGAs with the highest levels of tourism had three times the risk of murder/manslaughter but were significantly protective for child assault (IRR=0.58) and approached significance for daytime assaults (IRR=0.75, p=0.053), while mid-range tourism was significantly protective for sexual assault (IRR=0.64).

Table 11: Model results for assaults by location, Western Australia

Pseudo R^2	0.26			0.23			0.26			0.26			0.27		
	Total assaults			Assaults at on-site outlets			Assaults at private residences			Assaults in the street			Assaults at other places		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Density/alcohol sales variables															
Mean volume per off-site outlet (L)[a]	1.06*	1.03	1.09	1.06	0.98	1.14	1.06*	1.02	1.10	1.12*	1.07	1.18	1.04	1.00	1.08
Mean volume per on-site outlet (L)[a]	0.99	0.95	1.04	1.08	0.94	1.24	1.00	0.94	1.06	0.96	0.89	1.03	0.98	0.92	1.04
Number of off-site outlets[b]	1.00	0.99	1.01	1.01	0.97	1.04	1.00	0.98	1.01	0.98	0.95	1.01	1.00	0.98	1.02
Number of on-site outlets[b]	1.02*	1.01	1.02	1.03*	1.02	1.04	1.01*	1.01	1.02	1.03*	1.02	1.04	1.02*	1.01	1.02
Demographic and socioeconomic variables															
Total population aged 15+ (ERP) (ln)	3.30*	2.98	3.66	3.08*	2.34	4.05	3.35*	2.99	3.77	3.80*	3.20	4.50	3.17*	2.80	3.60
Average male age	0.88*	0.83	0.95	0.80*	0.66	0.96	0.93	0.85	1.01	0.89+	0.79	1.00	0.91*	0.83	1.00
Average female age	1.06*	1.00	1.12	1.24*	1.06	1.44	1.02	0.96	1.09	1.04	0.95	1.15	1.04	0.97	1.11
Percent males (15+ years)	1.04*	1.00	1.07	1.04	0.95	1.13	1.02	0.98	1.06	1.07*	1.01	1.13	1.04	1.00	1.08
SEIFA	0.99*	0.99	1.00	1.00	1.00	1.00	0.99*	0.99	1.00	0.99*	0.99	1.00	0.99*	0.99	1.00
Population density	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Indigenous population quantile															
0	(base)			(base)			(base)			(base)			(base)		
1	1.17	0.92	1.49	1.08	0.64	1.84	1.20	0.91	1.59	0.95	0.65	1.40	1.27	0.95	1.69
2	1.51*	1.16	1.96	1.35	0.72	2.54	1.57*	1.17	2.12	1.87*	1.22	2.87	1.55*	1.13	2.14
3	2.50*	1.79	3.49	2.13	0.95	4.78	2.97*	2.01	4.38	2.37*	1.36	4.10	2.41*	1.57	3.70
Mining															
No	(base)			(base)			(base)			(base)			(base)		
Yes	1.42*	1.05	1.91	1.34	0.65	2.77	1.26	0.89	1.80	1.70*	1.04	2.78	1.62*	1.12	2.35
ARIA															
1	(base)			(base)			(base)			(base)			(base)		

Table 11: Model results for assaults by location, Western Australia cont.

2	0.96	0.63	1.47	0.77	0.32	1.86	0.97	0.61	1.56	0.91	0.48	1.71	1.10	0.69	1.75
3	0.91	0.70	1.18	1.17	0.63	2.18	0.93	0.69	1.25	1.19	0.78	1.81	0.84	0.61	1.16
4	0.64*	0.45	0.91	0.70	0.28	1.77	0.72	0.47	1.09	0.57	0.31	1.05	0.75	0.47	1.19
5	0.85	0.58	1.24	1.59	0.67	3.79	0.81	0.52	1.26	0.94	0.51	1.72	0.91	0.58	1.45
Tourism quantile															
0	(base)			(base)			(base)			(base)			(base)		
1	0.83	0.64	1.07	1.14	0.65	2.01	0.74*	0.56	0.99	0.79	0.53	1.16	0.91	0.68	1.22
2	0.86	0.66	1.13	1.36	0.73	2.52	0.78	0.58	1.05	0.77	0.52	1.14	0.92	0.67	1.24

* $p<0.05$

+ $p=0.053$

a: Per adult aged 15 years or older

b: Per 10,000 adults aged 15 years or older

Table 12: Model results for assaults by victim age and sex subpopulation, Western Australia[a]

Pseudo R^2	0.27			0.33			0.30			0.29			0.22			0.32		
	Adult (15+ years)			Child (0–14 years)			Male			Female			People aged 15–30 years			Males aged 15–30 years		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Density/alcohol sales variables																		
Mean volume per off-site outlet (L)[b]	1.06*	1.03	1.09	1.08*	1.04	1.12	1.07*	1.04	1.11	1.06*	1.03	1.09	1.05*	1.00	1.09	1.08*	1.04	1.12
Mean volume per on-site outlet (L)[b]	0.99	0.95	1.04	0.98	0.91	1.05	1.00	0.95	1.05	0.97	0.93	1.02	0.88*	0.83	0.94	0.98	0.92	1.05
Number of off-site outlets[c]	1.00	0.99	1.01	0.99	0.96	1.01	0.99	0.97	1.01	1.00	0.99	1.02	1.00	0.98	1.02	1.00	0.98	1.02
Number of on-site outlets[c]	1.02*	1.01	1.02	1.02*	1.01	1.02	1.02*	1.02	1.03	1.02*	1.01	1.02	1.01*	1.00	1.01	1.02*	1.02	1.03
Demographic and socioeconomic variables																		
Total population aged 15+ (ERP) (ln)	3.20*	2.90	3.53	3.97*	3.50	4.50	3.38*	3.04	3.75	3.22*	2.92	3.56	2.45*	2.15	2.79	3.31*	2.91	3.76
Average male age	0.87*	0.81	0.93	0.98	0.87	1.09	0.86*	0.79	0.92	0.90*	0.84	0.97	0.90*	0.81	1.00	0.87*	0.79	0.95
Average female age	1.06*	1.01	1.12	1.00	0.92	1.10	1.08*	1.02	1.15	1.04	0.98	1.10	0.95	0.89	1.03	1.07	0.99	1.16
Percent males (15+ years)	1.05*	1.02	1.09	1.00	0.95	1.04	1.07*	1.03	1.10	1.05*	1.01	1.08	1.11*	1.06	1.17	1.07*	1.02	1.12
SEIFA	0.99*	0.99	1.00	0.99*	0.99	1.00	1.00*	0.99	1.00	0.99*	0.99	1.00	1.00*	0.99	1.00	1.00*	0.99	1.00
Population density	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Indigenous population quantile																		
0	(base)			(base)			(base)			(base)			(base)			(base)		
1	1.00	0.79	1.26	1.18	0.90	1.54	1.04	0.82	1.31	1.08	0.86	1.37	1.35	0.93	1.94	1.11	0.84	1.47
2	1.41*	1.09	1.82	1.95*	1.45	2.62	1.46*	1.13	1.90	1.65*	1.28	2.13	1.83*	1.24	2.72	1.66*	1.21	2.26
3	2.44*	1.76	3.38	2.99*	1.96	4.55	2.25*	1.61	3.16	3.03*	2.17	4.23	3.06*	1.85	5.07	2.19*	1.43	3.37
Mining																		
No	(base)			(base)			(base)			(base)			(base)			(base)		
Yes	1.35*	1.01	1.81	1.30	0.90	1.87	1.20	0.88	1.64	1.43*	1.07	1.93	0.85	0.55	1.32	1.22	0.83	1.81
ARIA																		
1	(base)			(base)			(base)			(base)			(base)			(base)		

Table 12: Model results for assaults by victim age and sex subpopulation, Western Australia[a] cont.

2	0.93	0.62	1.39	0.73	0.52	1.03	0.92	0.63	1.35	0.87	0.60	1.27	1.18	0.64	2.20	1.06	0.70	1.63
3	0.82	0.63	1.07	1.40*	1.04	1.88	0.94	0.72	1.22	0.85	0.66	1.10	0.84	0.57	1.25	0.90	0.65	1.22
4	0.58*	0.40	0.83	1.37	0.86	2.16	0.63*	0.44	0.92	0.67*	0.46	0.97	0.53*	0.31	0.91	0.52*	0.32	0.84
5	0.82	0.57	1.19	1.04	0.67	1.62	0.92	0.63	1.33	0.80	0.55	1.16	0.93	0.52	1.66	1.01	0.65	1.59
Tourism quantile																		
0	(base)			(base)			(base)			(base)			(base)			(base)		
1	0.85	0.67	1.09	0.81	0.63	1.03	0.86	0.68	1.09	0.83	0.65	1.05	1.07	0.73	1.57	0.93	0.70	1.22
2	0.91	0.70	1.18	0.58*	0.45	0.74	0.86	0.67	1.10	0.83	0.65	1.06	1.18	0.80	1.75	0.89	0.67	1.18

* $p<0.05$

a: Where victim known and age or sex reported

b: Per adult aged 15 years or older

c: Per 10,000 adults aged 15 years or older

Table 13: Model results for assaults by type, Western Australia

Pseudo R^2	0.28			0.28			0.30			0.36		
	Non-domestic			Domestic			Murder/manslaughter			Sexual		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Density/alcohol sales variables												
Mean volume per off-site outlet (L)[a]	1.07*	1.04	1.11	1.05*	1.02	1.09	1.04	0.84	1.28	1.07*	1.02	1.13
Mean volume per on-site outlet (L)[a]	0.99	0.94	1.04	0.98	0.92	1.03	1.13	0.88	1.44	1.00	0.92	1.09
Number of off-site outlets[b]	1.00	0.98	1.02	0.99	0.97	1.01	1.00	0.89	1.11	0.99	0.96	1.02
Number of on-site outlets[b]	1.02*	1.02	1.03	1.01*	1.01	1.02	0.98	0.95	1.01	1.02*	1.01	1.02
Demographic and socioeconomic variables												
Total population aged 15+ (ERP) (ln)	3.44*	3.08	3.84	3.20*	2.84	3.59	1.87*	1.23	2.85	3.23*	2.84	3.67
Average male age	0.86*	0.80	0.93	0.90*	0.82	0.97	1.05	0.71	1.55	1.03	0.92	1.15
Average female age	1.07*	1.01	1.14	1.05	0.98	1.12	0.89	0.64	1.25	0.95	0.87	1.05
Percent males (15+ years)	1.05*	1.02	1.09	1.05*	1.01	1.10	0.98	0.82	1.18	1.00	0.95	1.05
SEIFA	0.99*	0.99	1.00	0.99*	0.99	1.00	1.00	0.99	1.01	1.00*	0.99	1.00
Population density	1.00	1.00	1.00	1.00*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Indigenous population quantile												
0	(base)			(base)			(base)			(base)		
1	1.04	0.81	1.33	0.95	0.73	1.25	1.80	0.66	4.90	1.46*	1.11	1.92
2	1.61*	1.22	2.12	1.44*	1.07	1.95	0.46	0.13	1.66	1.87*	1.37	2.56
3	2.46*	1.73	3.49	3.10*	2.10	4.57	0.65	0.09	4.67	2.46*	1.50	4.02
Mining												
No	(base)			(base)			(base)			(base)		
Yes	1.26	0.91	1.74	1.41+	0.99	2.00	1.31	0.23	7.47	1.32	0.88	1.99
ARIA												
1	(base)			(base)			(base)			(base)		

Table 13: Model results for assaults by type, Western Australia cont.

2	0.93	0.62	1.41	0.84	0.54	1.32	0.74	0.16	3.35	1.26	0.92	1.72
3	0.93	0.71	1.22	0.80	0.59	1.08	1.62	0.54	4.87	1.27	0.92	1.75
4	0.59*	0.40	0.87	0.71	0.46	1.10	0.91	0.08	10.53	1.02	0.60	1.76
5	0.88	0.59	1.30	0.85	0.55	1.33	0.90	0.12	6.45	0.97	0.60	1.57
Tourism quantile												
0	(base)			(base)			(base)			(base)		
1	0.88	0.68	1.13	0.78	0.59	1.03	0.70	0.23	2.14	0.64*	0.50	0.83
2	0.88	0.67	1.14	0.76	0.57	1.01	3.01*	1.23	7.38	0.86	0.68	1.09

* $p<0.05$

$^{+}p=0.056$

a: Per adult aged 15 years or older

b: Per 10,000 adults aged 15 years or older

Table 14: Model results for assaults by time of day and weekend, Western Australia

Pseudo R^2	0.27			0.25			0.28		
	Night-time assaults			Daytime assaults			Weekend		
	IRR	95% CI		IRR	95% CI		IRR	95% CI	
Density/alcohol sales variables									
Mean volume per off-site outlet (L)[a]	1.08*	1.04	1.12	1.04*	1.00	1.08	1.07*	1.04	1.10
Mean volume per on-site outlet (L)[a]	1.00	0.94	1.06	0.99	0.93	1.04	0.97	0.93	1.02
Number of off-site outlets[b]	1.01	1.00	1.03	0.99	0.98	1.01	1.00	0.98	1.01
Number of on-site outlets[b]	1.02*	1.02	1.03	1.02*	1.01	1.02	1.02*	1.01	1.02
Demographic and socioeconomic variables									
Total population aged 15+ (ERP) (ln)	3.34*	2.92	3.83	3.32*	2.95	3.73	3.14*	2.83	3.47
Average male age	0.87*	0.79	0.96	0.91*	0.83	0.99	0.91*	0.85	0.98
Average female age	1.07	1.00	1.16	1.05	0.98	1.13	1.02	0.96	1.08
Percent males (15+ years)	1.05*	1.01	1.10	1.01	0.97	1.05	1.05*	1.01	1.08
SEIFA	1.00*	0.99	1.00	0.99*	0.99	1.00	0.99*	0.99	1.00
Population density	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Indigenous population quantile									
0	(base)			(base)			(base)		
1	1.28	0.94	1.73	1.31+	0.99	1.74	1.12	0.89	1.41
2	1.34	0.96	1.86	2.04*	1.50	2.77	1.58*	1.21	2.05
3	2.61*	1.70	4.01	2.92*	1.95	4.36	2.46*	1.75	3.44
Mining									
No	(base)			(base)			(base)		
Yes	1.59*	1.09	2.31	1.15*	0.80	1.66	1.41*	1.05	1.90
ARIA									
1	(base)			(base)			(base)		

Table 14: Model results for assaults by time of day and weekend, Western Australia cont.

2	1.14	0.69	1.88	0.96	0.61	1.49	0.98	0.65	1.45
3	0.94	0.67	1.31	0.90	0.66	1.23	0.80	0.62	1.04
4	0.77	0.48	1.22	0.55*	0.36	0.86	0.54*	0.37	0.77
5	0.84	0.52	1.33	0.92	0.59	1.45	0.71	0.49	1.02
Tourism quantile									
0	(base)			(base)			(base)		
1	0.90	0.66	1.23	0.79	0.60	1.04	0.86	0.67	1.10
2	0.98	0.71	1.36	0.75#	0.56	1.00	0.96	0.74	1.24

* $p<0.05$

+ $p=0.056$

$p=0.053$

a: Per adult aged 15 years or older

b: Per 10,000 adults aged 15 years or older

5.0 Discussion and Summary

This study investigated the association between assaults reported to police and a range of liquor outlet types using Queensland and WA data. The Queensland models distinguished between licences limited to only off-site alcohol purchases (bottleshops), those solely for on-site alcohol purchases (restaurants), and those with mixed on-site and off-site functions such as hotels, community clubs and other outlet types. Separate analyses were conducted by type of location where the assault occurred, age and sex of the victim, type of assault and time of day/day of week. All models were also adjusted for total alcohol sales made within each LGA and a range of demographic and socioeconomic factors. A similar approach was taken for Western Australia but the data additionally allowed all models to test the individual effects of outlet counts and outlet sales by on-site and off-site outlet types. A similar approach was applied by Liang and Chikritzhs (2011) in work previously undertaken on WA data for assaults reported to police.

Queensland

In keeping with the bulk of the epidemiological literature on outlet density, higher numbers of hotels/nightclubs were significantly associated with greater risk of common assault, assault among young males and assaults on children. For every additional 10 hotels/nightclubs, there was, on average, a 9 percent increase in the likelihood of common assault reported to police. This effect remained even when total alcohol sales within each LGA were adjusted for, implying that the effect of these outlets extended beyond that which could be explained by alcohol consumption alone and that the mere physical presence of these types of outlets is an important predictor of violence in Queensland. This observation concurs with a WA study by Liang and Chikritzhs (2011) that found that greater numbers of on-site outlets within an LGA predicted greater levels of assault, even when controlling for alcohol sales made by those premises, and that volumes of alcohol sold by on-site outlets did not significantly predict violence. The WA data, however, showed a considerably larger risk per on-site outlet such that for every 10 additional on-site outlets, the risk of assault increased by about 21 percent in an LGA. This may be partly due to methodological differences in the studies, including the fact that the WA study grouped all on-site outlet types together (including hotels/nightclubs, restaurants and cafes) whereas the current study separated hotels/nightclubs from restaurants.

Of particular note, numbers of restaurant licences in Queensland were significantly associated with higher risk of assaults at on-site outlets and in the street as well as weekend, male and serious assaults—although the effect was small and ranged from a one percent to a four percent increase in risk for every 10 additional outlets. A positive linear association for restaurants and violence is an uncommon finding in the literature as most studies tend to find either no relationship or a weak negative association (eg Gruenewald et al. 2006; Lipton & Gruenewald 2002; Livingston 2010; Zhu et al. 2004). One exception is an Australian study by Livingston (2008a), which used Victorian assault data. Livingston defined ‘on-premise’ outlets such that they excluded hotels and included restaurants, bars, nightclubs and other premises for which alcohol sales were not the primary service and found a significant positive linear association with violence. It is often argued that restaurants are at lower risk of harm due to their mixed function and usually mandatory requirement to only serve alcohol with a substantial meal, such as is the case in Western Australia (Stockwell et al. 1992). In contrast to most WA restaurants, however, where a meal must be served to be able to order an alcoholic drink, in Queensland, alcoholic drinks may be purchased for on-site consumption without ordering food (ie similar to a hotel). Moreover, of the Queensland licence types examined, restaurants make up the single largest group (28%) and it may be that their large numbers contribute measurably to the overall physical availability of alcohol, thereby posing a detectably increased risk for violence.

None of the models tested indicated a significant association between Queensland bottleshops and assaults reported to police. This is not entirely in keeping with recent Australian (eg Livingston 2011a, 2011b, 2008b; Liang & Chikritzhs 2011) or international (Pridemore & Grubesic 2011; Xu et al. 2012; Yu et al. 2008) outlet density literature, as many, but not all (eg Han & Gorman 2013), show a positive association. Liang and Chikritzhs (2011) have argued that outlet density studies that are not able to integrate alcohol sales data into their models may underestimate the true magnitude of the relation between off-site outlets and harm, as existing associations may be underpinned by economic rather than physical availability. In the Queensland component of this study, due to data limitations, it was not feasible to control for alcohol sales specific to bottleshops or other licence types and this may have substantially weakened capacity to identify off-site outlet-specific effects on violence. This is supported by the observation that higher levels of total alcohol sales in an LGA predicted significantly greater risk of assaults occurring at on-site outlets, assaults in the street, serious assaults and those involving female victims. Therefore, although it was not possible to control for alcohol sales specific to bottleshops in the Queensland models, it is noteworthy that total volume of alcohol sales in an LGA is a significant predictor for risk of violence in that area.

Furthermore, Livingston has demonstrated that cross-sectional studies can be prone to underestimating effects of off-site outlets. Livingston (2011b) applied a robust longitudinal design to 10 years of domestic incidents reported to Victoria Police. He found a strong positive association between packaged outlet density (off-site) and domestic violence, and a small positive association for other outlet types. Earlier, however, Livingston had applied a cross-sectional design to similar data from the same state, using similar geographic units and methods, but found no association between off-site outlets and domestic violence (Livingston 2010). Contrasting his previous cross-sectional work with the result from his longitudinal study, Livingston noted that:

> This highlights the possibility of misleading results in cross-sectional analyses, with the results of this longitudinal study providing a more intuitive set of relationships. In particular, the longitudinal analyses highlighted the substantial role of packaged liquor outlets in domestic violence, a relationship that was not detected in previous cross-sectional work. (Livingston 2011b: 923)

It is possible that a similar mechanism underlies the null results found for bottleshop effects in Queensland.

The proportion of the residential population estimated to have been Indigenous was a key predictor of Queensland assaults in most models, even when socioeconomic index, remoteness and all alcohol variables were controlled for. When compared with LGAs with less than 2 percent Indigenous residents, LGAs with Indigenous populations between 23 percent and 90 percent Indigenous (seventh quantile) were up to five times more at risk of assault. Overall, as the Indigenous population increased, the risk of assault also increased; however, the relationship was not entirely linear. LGAs where more than 90 percent of the population was Indigenous did not indicate increased risk of violence and in most cases showed a reduced risk or ‘protective’ effect (although rarely significant).[13] Pridemore and Grubesic (2012b: 151) posit that communities with high levels of organisation or ‘collective efficacy may buffer the effect of high outlet density on violence’. In the reverse, communities with low levels of social organisation may be less equipped to mitigate the negative effects of alcohol outlets and availability. Although small numbers of LGAs prevent a more fulsome expansion of analyses using these cross-sectional data, future analyses should investigate the potential for interaction effects between Indigenous status, numbers of outlets and alcohol sales.

There were also several novel findings to arise from this study. Compared with LGAs with the lowest levels of total alcohol sales, LGAs with higher levels of sales indicated lower risk of sexual assault (in the case of sales group two, this association was significant). It is not clear why this might be the case and this requires further investigation. Licence types categorised as ‘other’ were also found to have a protective effect for assaults occurring among children, young people and young males, and lower risk for common assaults and daytime assaults. It is noteworthy that among the group of ‘other’ licence types were premises such as motels, catering businesses, florists and movie theatres, and although all were in possession of a retail liquor licence, less than 50 percent were indicated as having purchased alcohol from a wholesaler in 2008–09. This suggests that apparent protective effects associated with these ‘other’ outlets may be due to characteristics of the premises and their surrounds, which are not related to the sale of alcohol per se.

13 Statistical significance indicating a protective effect was reached for the eighth Indigenous population quantiles in the night-time and sexual assault models.

This study controlled for the presence of substantial mining activity in an LGA. Petkova et al. (2009: 225) showed that for some Queensland mining townships, although mining activity may have bought economic advantages for the area, levels of social problems were also elevated; however, most mining towns were not the ‘wildly dysfunctional frontier towns of the popular imagination’. Carrington et al. (2010) have argued that there are high rates of violence among men residing in mining work camps and that a substantial proportion is due to non-resident workers (eg FIFO workers). It is surprising therefore that the Queensland models presented here demonstrate almost universally protective effects in relation to the presence of substantial mining activity within LGAs. Nevertheless, it is possible that this reflects a real effect at the LGA level and that LGAs with substantial mining activity are, overall, more highly socially organised areas, potentially incorporating a range of features protective for violence. It should be kept in mind that the LGA regions applied in these analyses are much larger than the small townships typically examined in Australian mining town case studies. Alternatively, it is also possible that apparently low levels of assault among mining LGAs overall are partly due to widespread under-reporting of violent incidents to police; however, this requires further investigation to be confirmed.

Western Australia

Overall outcomes from the WA models were generally in keeping with published work using data for assault offences reported to police and alcohol sales data (2000–01) from this state (Liang & Chikritzhs 2011). Controlling for a range of potential confounders, off-site outlet alcohol sales (but not off-site outlet numbers) were a significant predictor of violent assaults reported to police. The larger the amount of alcohol sales linked to off-site outlets within an LGA, the greater was the likelihood of assault offences reported to police. The risk was highest for assaults occurring in the street, assaults among young males and those occurring at night-time.

Counts of WA on-site outlets also predicted assault such that for total assaults, one new on-site outlet per 10,000 residential population increased the likelihood of assault by 2 percent. The effect was slightly higher, at 3 percent, for assaults occurring at on-site outlets. When assaults occurring specifically at restaurants were examined separately (Appendix E), numbers of both on-site outlets and off-site outlets were found to be significant predictors. This is an interesting finding given that among the Queensland data, small but significant effects were found for counts of restaurants on the likelihood of assaults occurring at on-site outlets and in the street.

From a methodological standpoint, it is noteworthy that numbers of off-site outlets did not significantly predict risk of assault in any of the WA models, whereas alcohol sales linked to off-site outlets were consistently predictive. In relation to the observation that counts of off-site outlets generally do not predict assaults, this was also found to be the case for Queensland, where counts of bottleshops (off-site) were not predictive of assault. In the WA models, however, the data allowed the inclusion of off-site-specific sales in the models, whereas the Queensland models were limited to using overall levels of sales.

As was found for Queensland, in Western Australia, Indigenous status was a predictor of assault offences; however, although Indigenous status was a key variable among most of the Queensland models, its contribution to the WA models was more moderate.

Study limitations

The unit of analysis in this study was the population rather than the individual, so the qualifications applicable to an ecological study apply here. It is a considerable strength of the WA analyses that they were able to include on-site and off-site outlet-specific alcohol sales. The Queensland models were not able to include alcohol sales specific to outlet types but they did control for total alcohol sales made at the LGA level. It was nevertheless disappointing that alcohol sales specific to outlet type could not be reliably determined for Queensland. This was an unexpected reporting outcome of the licensing system in Queensland, which links bottleshop licences to a primary hotel licence. The licensing system also requires that all but one bottleshop must be located away from the primary hotel site. In about half of all cases, detached bottleshops were located in different SLAs to that of their primary hotel. When wholesalers reported the sales they made to retailers during the previous year, they typically reported total sales made to the primary hotel licence number thus precluding identification of alcohol volumes distributed to linked yet geographically distinct bottleshops. From an analytical point of view, this created two limitations in the application of the alcohol sales data—first, in order to ensure that in the majority of cases alcohol sales from hotels and their linked bottleshops were attributed to the correct region, the minimum geographic level had to be set at 2008 LGAs, which included only 74 broad regions; and second, alcohol sales specific to bottleshops and alcohol sales specific to hotels could not be reliably identified and therefore alcohol sales predictor variables specific to licence type could not be applied in the models. Thus, the Queensland alcohol sales data could not support an approach that separated out the contributions of alcohol sales by outlet type.

In Queensland, some LGA boundaries were specifically created around predominantly Indigenous communities. Many of these LGAs were also subject to region-wide outright bans on alcohol sales as a direct or indirect result of alcohol-related problems among the local communities; 15 LGAs had active alcohol bans during the study period. As functionally atypical, these LGAs were excluded from the models, reducing the total number of LGAs available for analysis to 59 and limiting the number of explanatory variables that could be applied in the models. Nevertheless, even when LGAs with alcohol bans were excluded, a very strong positive association was found between the proportion of Indigenous residents in an LGA and the risk of assault. It is likely that for many communities with relatively large Indigenous populations, alcohol availability and outlet density are mediating factors between Indigenous status and violence; this needs to be further explored with larger samples of longitudinal data.

Observational studies cannot prove causation outright and caution should always be applied to interpreting results from observational studies even when associations are significant. It is also the case that the ability to infer causation is usually considered stronger for longitudinal studies than for cross-sectional studies. It is important therefore to confirm cross-sectional results with more robust longitudinal studies—especially when the former demonstrate small effects. Small effect sizes are particularly susceptible to being explained by residual confounding. This study used data derived from a 12-month period and it is plausible that associations apparent for one year may vary in other years. Future models might also be improved by controlling for the level of commercialisation within regions as well as reports of crimes other than assault—for example, burglary/theft and drunk and disorderly conduct.

Policy implications and recommendations

For the foreseeable future, there is likely to be a growing trend towards the application by liquor licensing decision makers of public-interest tests that consider harm, ill-health or public amenity effects of a liquor application. This may lead to a more purposeful reliance on objective local data to assist in evidence-based decision making.

For the first time, this study has demonstrated significant associations between numbers of assaults reported to police and numbers of hotels/nightclubs and restaurants for Queensland and confirmed previously found associations for Western Australia. The study has shown that off-site outlet alcohol sales and total volume of alcohol sales within a region are important predictors of assault. On this basis, it is reasonable to conclude that policy decisions that ultimately increase total alcohol sales within a community or that increase numbers of on-site outlets (eg hotels/nightclubs or restaurants) are more likely to exacerbate, rather than ameliorate, harms associated with alcohol. This warrants recommendation of a precautionary approach to future liquor licensing policy formulation and application in Australian jurisdictions.

This study did not find direct evidence for a specific effect of bottleshops on numbers of assaults in Queensland; this is not in keeping with the recent literature or findings from the WA models and should be treated with caution. It is possible that the results shown here for Queensland bottleshops reflect the shortcomings of the cross-sectional study design and the inability to identify sales specifically linked to bottleshops. It is also possible that the very strong associations demonstrated between Indigenous status and assault are mediated by off-site outlet access to alcohol, and this requires further investigation.

Recommendations for modelling off-site outlet density impacts in the future

There is currently intense interest in finding efficient and reliable ways to inform evidence-based liquor licensing decisions. One means of encouraging the uptake of evidence-based liquor licensing policy into the future might include the construction of a data-driven tool accessible to decision makers (and possibly others), which will enable an unbiased, independent means of assessing the quantifiable outcomes from liquor licensing decisions in relation to the health and safety of communities. To achieve this in a manner that would withstand the scrutiny of the liquor licensing decision makers, industry and the community, a great deal of careful groundwork must first be undertaken. Police can support research-related activities that will encourage the uptake of data-driven liquor licensing decision making in the future by:

- *Supporting the investigation of liquor outlet impacts on a wide range of crime and health-related harms.* These would include alcohol-related road crashes, drink-driving offences, drunk and disorderly offences, injury-related ED presentations, alcohol-related hospitalisations and death. Alcohol-related violence is only one of many societal problems attributable to alcohol. A more fulsome knowledge of the associations between alcohol and harm will improve understanding of the implications of regulation and policy decisions.
- *Encouraging the conduct of longitudinal research studies*. Compared with cross-sectional studies, causal inference is enhanced for longitudinal study designs (as temporal order is one important indicator of causality). Although the characteristics (potential confounders) of LGAs or other geographically defined areas vary greatly, longitudinal studies that model changes over time may provide a better estimation of the association between availability and alcohol-related harms given other characteristics remain relatively constant (or can be controlled for). Longitudinal study results are widely considered more reliable than cross-sectional studies and therefore are far more amenable to supporting predictive or decision-making models. Longitudinal studies rely on many years of data rather than one snapshot in time and are typically more expensive and time-consuming to conduct. As a result, longitudinal studies of outlet density have been only rarely conducted in Australia and are seldom funded by competitive grant agencies. Even rarer still are community-based randomised intervention trials or similar studies with experimental designs. These kinds of studies are able to assess causal relationships between alcohol availability and alcohol-related harms, but they are very difficult to carry out in practice (partly because it is very difficult to truly randomise interventions to communities) and, more often than not, the cost is prohibitive.
- *Supporting the uptake of alcohol sales data reporting in all jurisdictions.* Currently, alcohol sales data are only reported for Western Australia, Queensland and the Northern Territory (data may become available for the Australian Capital Territory in the near future). Records that enable the identification of wholesale sales made to individual liquor retailers are crucial for the development of reliable and flexible models for determining the potential impacts of changes to outlet density.

Current Australian work on outlet density modelling

In 2013, under the Special Research Initiative funding round, Healthway (Western Australia) funded the NDRI to conduct the first stage of a project aimed at modelling impacts of liquor licensing changes in Western Australia (including outlet density). The proposal described the data and structures required to construct a data-driven tool that would support evidence-based liquor licensing decision making in the future. The project proposes to use WA data in the first instance, as the state has one of the most comprehensive and reliable sources of data on alcohol sales, but the model is intended for expansion to all states—even those which do not currently collect alcohol sales data. The following provides an overview of the modelling project proposal.

The multi-stage modelling project will develop a model to assist in predicting the likely impacts of proposed/planned licensing changes on a range of alcohol-related indicators (eg ED presentations, road crashes, assaults) within Western Australia and other Australian jurisdictions. The model will take into account the features of a specifically proposed change to the liquor licensing landscape in a particular region (eg new liquor store, extended trading permit for existing hotel) and the demographic and socioeconomic characteristics of the location in which it will occur. Indicators of alcohol-related harms will be drawn from a range of reliable sources, including alcohol sales data, hospital admissions, ED presentations, deaths and assaults reported to police, and road crash data.

The final outcome will be a tool, accessible to decision makers and others (possibly the general community), which will enable an unbiased, independent means of assessing the quantifiable outcomes from liquor licensing decisions in relation to the health and safety of communities. The project and research plan are organised into four stages.

Stage one of the project will establish three longitudinal datasets using WA data to model the various effects of changes to outlet density and other known influencing characteristics such as trading hours and trading conditions (eg licence type, restaurants versus hotels) on indicators of alcohol-related harm. A longitudinal approach will enable a much stronger measure of potential causal associations than a cross-sectional approach and is crucial to supporting reliable and robust predictive analysis that seeks to estimate the impact of changes to liquor licensing over time. This stage will provide the necessary groundwork to underpin a predictive model that will forecast future liquor outlet impacts by collating retrospective data on liquor outlets, harm indicator data and demographic/socioeconomic data over time. The three databases will include—liquor licensing data (eg alcohol sales volumes, trading hours, licence types and special conditions of trade), a range of health and offence data, and demographic and socioeconomic data (eg population estimates, income, employment, SEIFA). It will be important to include details of other features of liquor licensing, such as trading hours, which may interact with outlet density effects.

> The harm indicator dataset will cover electronic records dating back to 1999 (where available) and include at a minimum—hospital admission and death data, ED data, assault offences reported to police, and drink-driving offences and road crashes reported to police. Ambulance call-out records and alcohol-related disorderly conduct offences may also be considered depending on their availability. Historical demographic and socioeconomic data will be obtained from the ABS.
>
> Stage two will widen the national relevance of the project by providing the foundations for identifying reliable proxy measures for alcohol sales. Currently, only Western Australia, Queensland and the Northern Territory collect alcohol sales data (the Australian Capital Territory will soon begin its collection). The establishment of a reliable proxy or suite of composite measures for alcohol sales will enhance the generalisability of the model to other jurisdictions but will also enable the impact of newly proposed outlets to be estimated at the time of application. For example, information that can be derived from planning submissions and business plans indicating floor space, refrigeration capacity, patron numbers (for on-site venues), parking bays, staff numbers, geographic location, proximity of other venues and other characteristics will be examined for their ability to predict the likely range of annual alcohol sales by premise type. From this, a matrix of characteristics for predicting the range of alcohol sales will be constructed for application to forecasting models in stage three.

Stage three will focus primarily on analysis and modelling. Stages two and three may be performed simultaneously. Stage four will centre on establishing a web-based interface that will allow users to enter basic information on a region of interest and produce up-to-date reports on the estimated impact on harm indicators of liquor licensing changes.

6.0 References

Australian Bureau of Statistics (ABS) 2013. *Crime victimisation, Australia, 2011–12*. Cat. no. 4530.0. Canberra: ABS

Australian Bureau of Statistics (ABS) 2011. *Recorded crime: Victims, Australia, 2010*. Cat. no. 4510.0. Canberra: ABS

Australian Bureau of Statistics (ABS) 2008. *Socio-economic indexes for areas (SEIFA).* Technical paper 2006. Cat. no. 2039.0.55.001. Canberra: ABSAustralian Institute of Health and Welfare (AIHW) 2011. *National drug strategy household survey report 2010.* Drug statistics series no. 25. Cat. no. PHE 145. Canberra: AIHW

Babor T 2009. Alcohol research and the alcoholic beverage industry: Issues, concerns and conflicts of interest. *Addiction* 104(s1): 34–47

Babor T, Caetano R, Casswell S, Edwards G, Giesbrecht N et al. 2010. *Alcohol: No ordinary commodity. Research and public policy*, 2nd ed. Oxford: Oxford University Press

Branas C, Elliott M, Richmond T, Culhane D & Wiebe D 2009. Alcohol consumption, alcohol outlets, and the risk of being assaulted with a gun. *Alcoholism: Clinical and Experimental Research* 33(5): 906–15. doi:10.1111/j.1530-0277.2009.00912.x

Burgess M & Moffatt S 2011. The association between alcohol outlet density and assaults on and around licensed premises. *Crime and Justice Bulletin: Contemporary Issues in Crime and Justice* no. 147. Sydney: NSW Bureau of Crime Statistics and Research

Cameron M, Cochrane W, McNeill K, Melbourne P, Morrison S et al. 2012. Alcohol outlet density is related to police events and motor vehicle accidents in Manukau City, New Zealand. *Australian and New Zealand Journal of Public Health* 36(6): 537–42. doi:10.1111/j.1753-6405.2012.00935.x

Carrington K, McIntosh A & Scott J 2010. Globalization, frontier masculinities and violence: Booze, blokes and brawls. *British Journal of Criminology* 50(3): 393–413. doi:10.1093/bjc/azq003

Catalano P, Chikritzhs T, Stockwell T, Webb M & Dietze P 2001. *Trends in per capita alcohol consumption in Australia, 1990/91–1998/99*. National Alcohol Indicators technical report, monograph no. 4. Perth: National Drug Research Institute, Curtin University of Technology

Chen M, Grube J & Gruenewald P 2010. Community alcohol outlet density and underage drinking. *Addiction* 105(2): 270–8. doi:10.1111/j.1360-0443.2009.02772.x

Chen M, Gruenewald P & Remer L 2009. Does alcohol outlet density affect youth access to alcohol? *Journal of Adolescent Health* 44(6): 582–9. doi:10.1016/j.jadohealth.2008.10.136

Chikritzhs T 2009. Australia, in Hadfield P (ed), *Nightlife and Crime: Social order and governance in international perspective*. Oxford: Oxford University Press: 307–24

Chikritzhs T, Catalano P, Pascal R & Henrickson N 2007. *Predicting alcohol-related harms from licensed outlet density: A feasibility study*. Hobart: National Drug Law Enforcement Research Fund

Cohen D, Ghosh-Dastidar B, Scribner R, Miu A, Scott M et al. 2006. Alcohol outlets, gonorrhea, and the Los Angeles civil unrest: A longitudinal analysis. *Social Science & Medicine* 62(12): 3062–71

Collins D & Lapsley H 2008. *The costs of tobacco, alcohol and illicit drug abuse to Australian society in 2004/05*. Canberra: Australian Department of Health and Ageing

Connor J, Kypri K, Bell M & 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* 65(10): 841–6. doi:10.1136/jech.2009.104935

Cunradi C, Mair C, Ponicki W & Remer L 2011. Alcohol outlets, neighborhood characteristics, and intimate partner violence: Ecological analysis of a California city. *Journal of Urban Health* 88(2): 191–200. doi:10.1007/s11524-011-9549-6

Cunradi C, Mair C, Ponicki W & Remer L 2012. Alcohol outlet density and intimate partner violence-related emergency department visits. *Alcoholism: Clinical and Experimental Research* 36(5): 847–53. doi:10.1111/j.1530-0277.2011.01683.x

Day P, Breetzke G, Kingham S & Campbell M 2012. Close proximity to alcohol outlets is associated with increased serious violent crime in New Zealand. *Australian and New Zealand Journal of Public Health* 36(1): 48–54. doi:10.1111/j.1753-6405.2012.00827.x

Donnelly N, Poynton S, Weatherburn D, Bamford E & Nottage J 2006. Liquor outlet concentrations and alcohol-related neighbourhood problems. *Alcohol Studies Bulletin* no. 8. Sydney: New South Wales Bureau of Crime Statistics and Research

Franklin F, La Veist T, Webster D & Pan W 2010. Alcohol outlets and violent crime in Washington, DC. *Western Journal of Emergency Medicine* 11(3): 283–90

Freisthler B 2004. A spatial analysis of social disorganization, alcohol access, and rates of child maltreatment in neighborhoods. *Children and Youth Services Review* 26(9): 803–19. doi:10.1016/j.childyouth.2004.02.022

Freisthler B & Weiss R 2008. Using Bayesian space-time models to understand the substance use environment and risk for being referred to child protective services. *Substance Use & Misuse* 43(2): 239–51. doi:10.1080/10826080701690649

Freisthler B, Midanik L & Gruenewald P 2004. Alcohol outlets and child physical abuse and neglect: Applying routine activities theory to the study of child maltreatment. *Journal of Studies of Alcohol* 65: 586–92

Freisthler B, Needell B & Gruenewald P 2005. Is the physical availability of alcohol and illicit drugs related to neighborhood rates of child maltreatment? *Child Abuse & Neglect* 29(9): 1049–60. doi:10.1016/j.chiabu.2004.12.014

Giacopassi D & Winn R 1995. Alcohol availability and alcohol-related crashes: Does distance make a difference? *American Journal of Drug and Alcohol Abuse* 21(3): 407–16

Grubesic T, Pridemore W, Williams D & Philip-Tabb L 2013. Alcohol outlet density and violence: The role of risky retailers and alcohol-related expenditures. *Alcohol and Alcoholism* 48(5): 613–19. doi:10.1093/alcalc/agt055

Gruenewald P & Remer L 2006. Changes in outlet densities affect violence rates. *Alcoholism: Clinical and Experimental Research* 30(7): 1184–93. doi:doi:10.1111/j.1530-0277.2006.00141.x

Gruenewald P, Freisthler B, Remer L, La Scala E & Treno A 2006. Ecological models of alcohol outlets and violent assaults: Crime potentials and geospatial analysis. *Addiction* 101(5): 666–77. doi:10.1111/j.1360-0443.2006.01405.x

Gruenewald P, Freisthler B, Remer L, La Scala E, Treno A et al. 2010. Ecological associations of alcohol outlets with underage and young adult injuries. *Alcoholism: Clinical and Experimental Research* 34(3): 519–27. doi:10.1111/j.1530-0277.2009.01117.x

Gruenewald P, Millar A, Treno A, Yang Z, Ponicki W et al. 1996. The geography of availability and driving after drinking. *Addiction* 91(7): 967–83. doi:10.1046/j.1360-0443.1996.9179674.x

Han D & Gorman D 2013. Evaluating the effects of the introduction of off-sale alcohol outlets on violent crime. *Alcohol and Alcoholism* 48(3): 370–4. doi:10.1093/alcalc/agt015

Huckle T, Huakau J, Sweetsur P, Huisman O & Casswell S 2008. Density of alcohol outlets and teenage drinking: Living in an alcogenic environment is associated with higher consumption in a metropolitan setting. *Addiction* 103(10): 1614–21. doi:10.1111/j.1360-0443.2008.02318.x

Jewell R & Brown R 1995. Alcohol availability and alcohol-related motor vehicle accidents. *Applied Economics* 27(8): 759–65. doi:10.1080/00036849500000066

Johnson F, Gruenewald P & Remer L 2009. Suicide and alcohol: Do outlets play a role? *Alcoholism: Clinical and Experimental Research* 33(12): 2124–33. doi:10.1111/j.1530-0277.2009.01052.x

Kavanagh A, Kelly M, Krnjacki L, Thornton L, Jolley D et al. 2011. Access to alcohol outlets and harmful alcohol consumption: A multi-level study in Melbourne, Australia. *Addiction* 106(10): 1772–9. doi:10.1111/j.1360-0443.2011.03510.x

Kuntsche E, Kuendig H & Gmel G 2008. Alcohol outlet density, perceived availability and adolescent alcohol use: A multilevel structural equation model. *Journal of Epidemiology and Community Health* 62(9): 811–16. doi:10.1136/jech.2007.065367

Kypri K, Bell M, Hay G & Baxter J 2008. Alcohol outlet density and university student drinking: A national study. *Addiction* 103(7): 1131–8. doi:10.1111/j.1360-0443.2008.02239.x

La Scala E, Johnson F & Gruenewald P 2001. Neighborhood characteristics of alcohol-related pedestrian injury collisions: A geostatistical analysis. *Prevention Science* 2(2): 123–34. doi:10.1023/A:1011547831475

Liang W & Chikritzhs T 2011. Revealing the link between licensed outlets and violence: Counting venues versus measuring alcohol availability. *Drug and Alcohol Review* 30(5): 524–35. doi:10.1111/j.1465-3362.2010.00281.x

Lipton R & Gruenewald P 2002. The spatial dynamics of violence and alcohol outlets. *Journal of Studies on Alcohol* 63(2): 187–95.

Livingston M 2011a. Alcohol outlet density and harm: comparing the impacts on violence and chronic harms. *Drug and Alcohol Review* 30(5): 515–23. doi:10.1111/j.1465-3362.2010.00251.x

Livingston M 2011b. A longitudinal analysis of alcohol outlet density and domestic violence. *Addiction* 106(5): 919–25. doi:10.1111/j.1360-0443.2010.03333.x

Livingston M 2010. The ecology of domestic violence: The role of alcohol outlet density. *Geospatial Health* 5(1): 139–49

Livingston M 2008a. Alcohol outlet density and assault: A spatial analysis. *Addiction* 103(4): 619–28. doi:10.1111/j.1360-0443.2008.02136.x

Livingston M 2008b. A longitudinal analysis of alcohol outlet density and assault. *Alcoholism: Clinical and Experimental Research* 32(6): 1074–9. doi:10.1111/j.1530-0277.2008.00669.x

Livingston M, Chikritzhs T & Room R 2007. Changing the density of alcohol outlets to reduce alcohol-related problems. *Drug and Alcohol Review* 26(5): 557–66. doi:10.1080/09595230701499191

Loxley W, Chikritzhs T & Catalano P 2011. *National alcohol sales data project: Stage 2 final report*. Perth: Drug and Alcohol Office of Western Australia

Loxley W, Chikritzhs T & Catalano P 2009. *National alcohol sales data project: Stage 1 final report*. Perth: Drug and Alcohol Office of Western Australia

McKinney C, Caetano R, Harris T & Ebama M 2009. Alcohol availability and intimate partner violence among US couples. *Alcoholism: Clinical and Experimental Research* 33(1): 169–76. doi:10.1111/j.1530-0277.2008.00825.x

Nicholas R 2010. *An environmental scan on alcohol and other drug issues facing law enforcement in Australia 2010.* Hobart: National Drug Law Enforcement Research Fund

Nicholas R 2008. *Understanding and responding to alcohol-related social harms in Australia: Options for policing*. Hobart: National Drug Law Enforcement Research Fund

Nichols B, Nkalamo D & Whitcomb B 2012. Density of drinking establishments and HIV prevalence in a migrant town in Namibia. *AIDS and Behavior* 16(4): 829–34. doi:10.1007/s10461-011-9956-4

Nyaronga D, Greenfield T & McDaniel P 2009. Drinking context and drinking problems among black, white, and Hispanic men and women in the 1984, 1995, and 2005 US national alcohol surveys. *Journal of Studies on Alcohol and Drugs* 70(1): 16–26

Parker R, Williams K, McCaffree K, Acensio E, Browne A et al. 2011. Alcohol availability and youth homicide in the 91 largest US cities, 1984–2006. *Drug and Alcohol Review* 30(5): 505–14. doi:10.1111/j.1465-3362.2011.00336.x

Pereira G, Wood L, Foster S & Haggar F 2013. Access to alcohol outlets, alcohol consumption and mental health. *PLOS ONE* 8(1). doi:10.1371/journal.pone.0053461

Petkova V, Lockie S, Rolfe J & Ivanova G 2009. Mining developments and social impacts on communities: Bowen Basin case studies. *Rural Society* 19(3): 211–28

Popova S, Giesbrecht N, Bekmuradov D & Patra J 2009. Hours and days of sale and density of alcohol outlets: Impacts on alcohol consumption and damage. A systematic review. *Alcohol and Alcoholism* 44(5): 500–16. doi:10.1093/alcalc/agp054

Pridemore W & Grubesic T 2012a. Community organization moderates the effect of alcohol outlet density on violence. *The British Journal of Sociology* 63(4): 680–703. doi:10.1111/j.1468-4446.2012.01432.x

Pridemore W & Grubesic T 2012b. A spatial analysis of the moderating effects of land use on the association between alcohol outlet density and violence in urban areas. *Drug and Alcohol Review* 31(4): 385–93. doi:10.1111/j.1465-3362.2011.00329.x

Pridemore W & Grubesic T 2011. Alcohol outlets and community levels of interpersonal violence: Spatial density, outlet type, and seriousness of assault. *Journal of Research in Crime and Delinquency* 50(1): 132–59. doi:10.1177/0022427810397952

Rajendram R, Lewison G & Preedy V 2006. Worldwide alcohol-related research and the disease burden. *Alcohol and Alcoholism* 41(1): 99–106. doi:10.1093/alcalc/agh238

Ray J, Moineddin R, Bell C, Thiruchelvam D, Creatore M et al. 2008. Alcohol sales and risk of serious assault. *PLOS Medicine* 5(5): e104 (0724–31). doi:10.1371/journal.pmed.0050104

Reboussin B, Song E & Wolfson M 2011. The impact of alcohol outlet density on the geographic clustering of underage drinking behaviors within census tracts. *Alcoholism: Clinical and Experimental Research* 35(8): 1541–9. doi:10.1111/j.1530-0277.2011.01491.x

Resko S, Walton M, Bingham C, Shope J, Zimmerman M et al. 2010. Alcohol availability and violence among inner-city adolescents: A multi-level analysis of the role of alcohol outlet density. *American Journal of Community Psychology* 46(3–4): 253–62. doi:10.1007/s10464-010-9353-6

Roman C & Reid S 2012. Assessing the relationship between alcohol outlets and domestic violence: Routine activities and the neighborhood environment. *Violence and Victims* 27(5): 811–28. doi:10.1891/0886-6708.27.5.811

Scribner R, Cohen D, Kaplan S & Allen S 1999. Alcohol availability and homicide in New Orleans: Conceptual considerations for small area analysis of the effect of alcohol outlet density. *Journal of Studies on Alcohol* 60(3): 310–16

Scribner R, Mackinnon D & Dwyer J 1994. Alcohol outlet density and motor-vehicle crashes in Los-Angeles-County cities. *Journal of Studies on Alcohol* 55(4): 447–53

Shamblen S, Harris M, Ringwalt C, Flewelling R, Clark H et al. 2011. Outlet density as a predictor of alcohol use in early adolescence. *Substance Use & Misuse* 46(8): 1049–59. doi:10.3109/10826084.2011.552933

STATA 2009. *Stata base reference manual, Release 11*. College Station, TX: StataCorp LP

Stevenson M, Brewer R & Lee V 1998. The spatial relationship between licensed alcohol outlets and alcohol-related motor vehicle crashes in Gwinnett County, Georgia. *Journal of Safety Research* 29(3): 197–203. doi:10.1016/S0022-4375(98)00016-4

Stevenson R, Lind B & Weatherburn D 1999a. Property damage and public disorder: Their relationship with sales of alcohol in New South Wales, Australia. *Drug and Alcohol Dependence* 54(2): 163–70. doi:10.1016/S0376-8716(98)00157-4

Stevenson R, Lind B & Weatherburn D 1999b. The relationship between alcohol sales and assault in New South Wales, Australia. *Addiction* 94: 397–410

Stockwell T 2006. Alcohol supply, demand, and harm reduction: What is the strongest cocktail? *International Journal of Drug Policy* 17(4): 269–77. doi:10.1016/j.drugpo.2005.10.007

Stockwell T & Gruenewald P 2004. Controls on physical availability of alcohol, in Heather N & Stockwell T (eds), *The Essential Handbook of Treatment and Prevention of Alcohol Problems*. Chichester: Wiley & Sons: 213–234.

Stockwell T, Masters L, Phillips M, Daly A, Gahegan M et al. 1998. Consumption of different alcoholic beverages as predictors of local rates of night-time assault and acute alcohol-related morbidity. *Australian and New Zealand Journal of Public Health* 22(2): 237–42

Stockwell T, Somerford P & Lang E 1992. The relationship between licence type and alcohol-related problems attributed to licensed premises in Perth, Western Australia. *Journal of Studies on Alcohol* 53(5): 495–8

Stockwell T, Zhao J, Macdonald S, Pakula B, Gruenewald P et al. 2009. Changes in per capita alcohol sales during the partial privatization of British Columbia's retail alcohol monopoly 2003–2008: A multi-level local area analysis. *Addiction* 104(11): 1827–36. doi:10.1111/j.1360-0443.2009.02658.x

Stockwell T, Zhao J, Macdonald S, Vallance K, Gruenewald P et al. 2011. Impact on alcohol-related mortality of a rapid rise in the density of private liquor outlets in British Columbia: A local area multi-level analysis. *Addiction* 106(4): 768–76. doi:10.1111/j.1360-0443.2010.03331.x

Tatlow J, Clapp J & Hohman M 2000. The relationship between the geographic density of alcohol outlets and alcohol-related hospital admissions in San Diego County. *Journal of Community Health* 25(1): 79–88. doi:10.1023/A:1005145018975

Toomey T, Erickson D, Carlin B, Lenk K, Quick H et al. 2012. The association between density of alcohol establishments and violent crime within urban neighborhoods. *Alcoholism: Clinical and Experimental Research* 36(8): 1468–73. doi:10.1111/j.1530-0277.2012.01753.x

Treno A, Grube J & Martin S 2003. Alcohol availability as a predictor of youth drinking and driving: A hierarchical analysis of survey and archival data. *Alcoholism: Clinical and Experimental Research* 27(5): 835–40. doi:10.1097/01.Alc.0000067979.85714.22

Treno A, Gruenewald P & Johnson F 2001. Alcohol availability and injury: The role of local outlet densities. *Alcoholism: Clinical and Experimental Research* 25(10): 1467–71. doi:10.1111/j.1530-0277.2001.tb02148.x

Treno A, Johnson F, Remer L & Gruenewald P 2007. The impact of outlet densities on alcohol-related crashes: A spatial panel approach. *Accident Analysis & Prevention* 39(5): 894–901. doi:10.1016/j.aap.2006.12.011

Truong K & Sturm R 2009. Alcohol environments and disparities in exposure associated with adolescent drinking in California. *American Journal of Public Health* 99(2): 264–70. doi:10.2105/AJPH.2007.122077

Wechsler H, Lee J, Hall J, Wagenaar A & Lee H 2002. Secondhand effects of student alcohol use reported by neighbors of colleges: The role of alcohol outlets. *Social Science & Medicine* 55(3): 425–35. doi:10.1016/S0277-9536(01)00259-3

Weitzman E, Folkman A, Folkman M & Wechsler H 2003. The relationship of alcohol outlet density to heavy and frequent drinking and drinking-related problems among college students at eight universities. *Health & Place* 9(1): 1–6. doi:10.1016/S1353-8292(02)00014-X

Wilkinson C & Livingston M 2012. Distances to on- and off-premise alcohol outlets and experiences of alcohol-related amenity problems. *Drug and Alcohol Review* 31(4): 394–401. doi:10.1111/j.1465-3362.2011.00346.x

World Health Organization (WHO) 2011. *Global status report on alcohol and health*. Geneva: WHO

World Health Organization (WHO) 2006. *International guide for monitoring alcohol consumption and related harms*, 2nd ed. Geneva: Department of Mental Health and Substance Abuse, Noncommunicable Diseases and Mental Health Cluster, WHO

Xu Y, Yu Q, Scribner R, Theall K, Scribner S et al. 2012. Multilevel spatiotemporal change-point models for evaluating the effect of an alcohol outlet control policy on changes in neighborhood assaultive violence rates. *Spatial and Spatio-temporal Epidemiology* 3(2): 121–8. doi:10.1016/j.sste.2012.04.005

Young R, Macdonald L & Ellaway A 2013. Associations between proximity and density of local alcohol outlets and alcohol use among Scottish adolescents. *Health Place* 19: 124–30. doi:10.1016/j.healthplace.2012.10.004

Yu Q, Scribner R, Carlin B, Theall K, Simonsen N et al. 2008. Multilevel spatio-temporal dual changepoint models for relating alcohol outlet destruction and changes in neighbourhood rates of assaultive violence. *Geospatial Health* 2(2): 161–72

Zhu L, Gorman D & Horel S 2004. Alcohol outlet density and violence: A geospatial analysis. *Alcohol and Alcoholism* 39(4): 369–75. doi:10.1093/alcalc/agh062

Appendix A

List of Queensland licence types:

Commercial hotel

Commercial other—Industrial canteen

Commercial other—Producer/wholesaler

Commercial other—Subsidiary off-premises

Commercial other—Subsidiary on-premises

Commercial special facility

Community club

Community other

Wine merchant

Wine producer

List of Queensland site types:

Adult entertainment	Nightclub
Airport	Private golf course
Art gallery	Producer/wholesaler
Casino	Racecourse
Caterer	Resort
Club	Restaurant
Cultural centre	Retirement village
Detached bottleshop	School
Florist/gift basket	Special facility
Function room	Theatre/cinema
Hospital	Tourist attraction
Hotel	Train
Indoor sporting centre	Training college
Industrial canteen	Vessel
Miscellaneous	Wine
Motel	

Source: Queensland Office of Liquor and Gaming Regulation (OLGR) and the Office of Regulatory Policy

Appendix B

Alcohol conversion factors for Queensland:

Heavy beer	0.0476
Medium beer	0.0348
Light beer	0.0269
Bottled table wine	0.1230
Cask table wine	0.1230
Bottled fortified wine	0.1790
Cask fortified wine	0.1790
Regular spirits	0.4170
Pre-mixed spirits	0.0501
Alcoholic soda	0.0500
Cider	0.0500
Mead	0.1250

Source: Loxley et al. 2011: 37

Appendix C

List of WA licence types:

Hotel	Special facility—Education and training institute
Tavern	Special facility—Sports arena
Liquor store	Special facility—Food hall
Club	Special facility—Caterer
Hotel restricted	Special facility—Bed & breakfast
Restaurant	Special facility—Room service
Nightclub	Special facility—Amusement venue
Special facility—Winehouse	Special facility—Wine club
Special facility—Canteen	Special facility—Liquor auction
Special facility—Theatre	Small bar
Special facility—Packet/transport	Special facility—Education and training courses
Special facility—Ballroom	Special facility—1988 LL Act Transitional
Special facility—Reception centre	Special facility—Section 37 Interpretation Act Savings
Special facility—Australian wine	Tavern restricted
Special facility—Refreshment room	Special facility
Club restricted	
Special facility—Historic inn	
Casino liquor	
Special facility—Tourism	
Special facility—Other	
Special facility—Supplier	

Source: Government of Western Australia Department of Racing, Gaming and Liquor (DRGL) and the Drug and Alcohol Office (DAO)

Appendix D

Alcohol conversion factors for Western Australia:

Heavy beer	0.0476
Light beer	0.0348
High wine	0.1230
Low wine	0.0350
Spirits	0.1060

Source: Loxley et al. 2011: 37

Appendix E

Model results for assaults occurring at hotels/taverns and restaurants, Western Australia

Pseudo R2	0.23			0.44		
	Hotels/taverns			Restaurants		
	IRR	95% CI		IRR	95% CI	
Density/alcohol sales variables						
Mean volume per off-site outlet (L)a	1.07+	1.00	1.14	1.09	0.90	1.32
Mean volume per on-site outlet (L)a	1.07	0.94	1.21	0.67	0.32	1.42
Number of off-site outletsb	1.00	0.96	1.03	1.11*	1.02	1.20
Number of on-site outletsb	1.02*	1.01	1.03	1.04*	1.02	1.06
Demographic and socioeconomic variables						
Total population aged 15+ (ERP) (ln)	2.47*	1.94	3.15	4.74*	3.25	6.93
Average male age	0.85	0.72	1.01	0.78	0.58	1.03
Average female age	1.17*	1.02	1.35	1.33*	1.04	1.68
Percent males (15+ years)	1.01	0.94	1.10	1.03	0.92	1.15
SEIFA	1.00	1.00	1.00	1.00	0.99	1.01
Population density	1.00	1.00	1.00	1.00	1.00	1.00
Indigenous population quantile						
0	(base)			(base)		
1	1.12	0.68	1.84	1.18	0.67	2.06
2	1.33	0.75	2.37	3.45*	1.65	7.23
3	2.00	0.95	4.21	5.95*	1.51	23.51
Mining						
No	(base)			(base)		
Yes	1.27*	0.66	2.47	0.58	0.18	1.88
ARIA						
1	(base)			(base)		
2	0.46	0.21	1.03	1.17	0.65	2.11
3	0.93	0.52	1.65	0.59	0.24	1.47
4	0.62	0.27	1.45	0.17	0.01	2.02
5	1.63	0.74	3.56	2.81	0.85	9.31
Tourism quantile						
0	(base)			(base)		
1	1.11	0.66	1.86	0.62*	0.39	0.99
2	1.40	0.82	2.41	0.40*	0.25	0.64

* $p<0.05$

+ $p=0.07$

a: Per adult aged 15 years or older

b: Per 10,000 adults aged 15 years or older