

# **The effects of extended public transport operating hours and venue lockout policies on drinking-related harms in Melbourne, Australia: Results from SimDrink, an agent-based simulation model**

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## **Abstract**

*Background:* The late-night accessibility of entertainment precincts is a contributing factor to acute drinking-related harms. Using computer simulation we test the effects of improved public transport (PT) and venue lockouts on verbal aggression, consumption-related harms and transport-related harms among a population of young adults engaging in heavy drinking in Melbourne.

*Methods:* Using an agent-based model we implemented: a two-hour PT extension/24-hour PT; 1am/3am venue lockouts; and combinations of both. Outcomes determined for outer-urban (OU) and inner-city (IC) residents were: the number of incidents of verbal aggression inside public and private venues; the number of people ejected from public venues for being intoxicated; and the percentage of people experiencing verbal aggression, consumption-related harms and transport-related harms.

*Results:* All-night PT reduced verbal aggression in the model by 21% but displaced some incidents among OU residents from private to public settings. Comparatively, 1am lockouts reduced verbal aggression in the model by 19% but led to IC residents spending more time in private rather than public venues where their consumption-related harms increased. Extending PT by two hours had similar outcomes to 24-hour PT except with fewer incidents of verbal aggression displaced. Although 3am lockouts were inferior to 1am lockouts, when modelled in combination with any extension of PT both policies were similar.

*Conclusions:* A two-hour extension of PT is likely to be more effective in reducing verbal aggression and consumption-related harms than venue lockouts. Modelling a further extension of PT to 24 hours had minimal additional benefits but the potential to displace incidents of verbal aggression among OU residents from private to public venues.

*Keywords:* agent-based model; alcohol; drinking-related harms; public transport; SimDrink; venue lockouts; verbal aggression

## Introduction

There is a complex relationship between the late-night accessibility of entertainment precincts and drinking-related harms. In particular, negotiating a journey home late at night is considered a concern for personal safety (Measham & Brain, 2005) and when public transport (PT) is not available regulated closing times for public venues create spikes in taxi demand that can lead to disputes or aggression in taxi queues. This is potentially exacerbated by policies such as mandatory venue lockouts (where venues and services remain open but entrance is not allowed) that leave many people simultaneously requiring transport. In Melbourne, Australia, creating a safe 24-hour city has been set as a goal of local planners, and limited late night transport has been flagged as a current barrier (City of Melbourne, 2010).

Melbourne's CBD is heavily populated with bars and nightclubs that are popular among 18-25 year olds. Travelling from outer-urban (OU) areas for a night out in inner-city (IC) entertainment precincts is common among this population (MacLean & Moore, 2014), yet despite many venue licences and individuals' nights out exceeding 1am there is limited PT available after this time. Beyond 1am, the only PT option is a 'nightrider' bus network that operates from the city centre (Public Transport Victoria, 2015b). However, due to poor coverage, lack of connectivity and security concerns, this is not considered to be an attractive or safe option for many young adults (Duff & Moore, 2015; MacLean & Moore, 2014). This inadequacy of PT is problematic, as not only can taxi fares be in excess of AUD80—leaving individuals who are unable to afford a taxi home waiting in the street for PT to start in the morning—but Melbourne's liquor licensing means that venues share common closing times, leading to long waits for taxis and the potential for the above-mentioned disputes and aggression. To reduce these harms it has been proposed that 24-hour PT should operate on Friday and Saturday nights and a 12-month trial has been commissioned to start in January 2016. However, the benefits and indirect effects of such a trial are yet to be quantified.

It is hypothesised that the provision of inexpensive PT throughout the night will ease taxi demand and minimise the amount of people who extend their nights out while waiting for the next morning's first train. Thus, extending PT could potentially reduce disputes and lower incidental alcohol consumption. However, it is also plausible that increasing the late-night accessibility of entertainment precincts could *increase* alcohol consumption, particularly if the flow of city-bound individuals were to increase after 1am, or if people who would typically catch the last train home were to extend their nights *because* of extra PT provisions. In both cases, the additional time spent in entertainment precincts would be after 1am, the time when individuals are most likely to be intoxicated (Miller, et al., 2013) and consequently at highest risk of experiencing consumption-related harms (i.e. drinking beyond their physiological limits, in contrast to other drinking-related harms such as experiencing verbal aggression) (Measham & Brain, 2005). These contrasting outlooks highlight the wide range of effects that could emerge from the implementation of PT-related alcohol policies.

Another policy option central to much debate within Australia is venue lockouts. In February 2014, following a rise in drinking-related violence in Sydney, a two year trial of 1.30am lockouts and 3am closing times were introduced in Kings Cross and the Sydney CBD. Preliminary findings suggest that this led to a 26-32% decrease in assaults (Menéndez, Weatherburn, Kypri, & Fitzgerald, 2015) with limited displacement effects (a simultaneous 9% decrease across the rest of NSW was also reported), although it is unclear whether these decreases were simply the result of reduced pedestrian traffic at night. In 2008, Melbourne's city council introduced a three month trial (March, April and May) of 2am lockouts for public venues across four local government areas (LGAs) (Department of Transport, 2015)—Melbourne's CBD (including Docklands), Port Phillip, Yarra and Stonington. However, the implementation of the policy was flawed, as although there were 487

venues within this area, 120 (25%) were granted exemptions by the Victorian Civil and Administrative Tribunal, many of which were nightclubs either in close proximity to venues with lockouts or located centrally within entertainment precincts (46 out of the 85 nightclubs obtained exemptions). The large number of exemptions created community confusion about the policy that limited its effectiveness, and an evaluation found mixed results (Department of Justice, 2008). Despite this, the Sydney data would indicate the potential for success in Melbourne, in particular in the context of improved PT, and modelling these benefits would be useful for informing policy discussion.

Changes to transport and venue lockout policies are likely to affect different people in different ways, depending on where they live, where they normally drink and other personal characteristics (Callinan, Room, Livingston, & Jiang, 2015; Hart, 2015; MacLean, Ferris, & Livingston, 2013; Meier, Purshouse, & Brennan, 2010). Often models used to test alcohol policy options inadequately capture these differences, and are therefore prone to error if results are extrapolated. Agent-based models (ABMs) are types of models that address this issue by using a set of autonomous 'agents' to represent a population (Gilbert, 2008). Each agent is given unique characteristics and follows simple behavioural rules to interact with others and their environment. When many agents are combined and simulated together, their individualised characteristics provide a representation of a real-world population, and large scale behavioural patterns can emerge from a multitude of local, stochastic interactions. This offers a powerful and complex method for describing human behaviour, which has been successfully applied to alcohol policy research previously (Giabbanelli & Crutzen, 2013; Gorman, Mezic, Mezic, & Gruenewald, 2006; Lamy, Perez, Ritter, & Livingston, 2011).

In this paper we use an ABM SimDrink, developed in Scott et al. (Scott, et al., 2015), to virtually implement combinations of 24-hour PT and venue lockout policies in Melbourne. The model is designed to capture the net effects of alcohol policies on a population of 18-25 year old heavy drinkers, measuring the resulting prevalence of experiencing verbal aggression, consumption-related harms and difficulty getting home. The approach taken is novel because it involves simulating and tracking a population on an hourly time scale throughout the course of a night. This is consistent with the shift in contemporary alcohol and other drug research towards considering the consumption event as the unit of analysis (Bøhling, 2014; Callinan, Livingston, Dietze, & Room, 2014; Dilkes-Frayne, 2014; Kuntsche, Dietze, & Jenkinson, 2014); researchers are attempting to understand individuals' decisions and their consequences within a single drinking event (a 'big night out'). By using this type of simulation model to compare hypothetical time-specific (i.e. hour of day specific) policies, this study is an example of how modelling can provide insight into the mechanisms by which interventions can affect outcomes. Further, although the model has been applied to Melbourne, these results are applicable to other settings that have similar characteristics—namely locations with a central entertainment precinct that attracts both local residents and residents from surrounding suburbs.

## **Methods**

### *The model*

SimDrink is an existing ABM (Scott, et al., 2015), which simulates a population of young (18-25 year olds) people from Melbourne (either residing in IC or OU areas) meeting up with friends, who then move between private, public-niche (e.g. pubs, bars) and public-commercial (e.g. nightclubs) venues over the course of a night (Barton & Husk, 2012). The model tracks individuals' alcohol consumption, spending and whether or not they experience verbal aggression, drink more than their physiological

limits (experience ‘consumption-related harms’) or have difficulty getting home (experience ‘transport-related harms’). A detailed model description is provided in Appendix A, parameters used for the model are in provided in Appendix B, and further information including model sensitivities can be found in (Scott, et al., 2015).

### Model assumptions and the psychosocial characteristics of drinking in Australia

The model makes several underlying assumptions about the single-occasion drinking sessions of young Australians. In particular, the model assumes:

- Public locations attended by young drinkers from both OU and IC areas are typically in the IC (MacLean & Moore, 2014);
- It is common for people to move between venues (including between public and private settings) throughout the course of a single night (Dietze, Livingston, Callinan, & Room, 2014; Miller, et al., 2013)
- Individuals drink at different rates in different settings (i.e. in public-niche versus public-commercial) and when intoxicated (Lindsay, 2005);
- Friendship groups don’t split up when changing venues, with the exception of some members going home (Miller, et al., 2013—the most common reasons for young people to attend drinking environments is either to socialise with friends or for special events/celebrations);
- Due to both peer-pressure and safety concerns (in particular among OU residents), after exceeding their planned length of night people will only go home if at least one friend has also exceeded their planned length of night (Duff & Moore, 2015—also based on extensive fieldwork from AH and JW); and

- Given the high cost of taxis in Melbourne, most people will be aware of the last train departure time and many people are likely to make specific efforts to catch the last train home (Duff & Moore, 2015—also based on extensive fieldwork from AH and JW).

The extent to which these features are unique to Australia may limit the generalisability of this model to other international settings. For the model to be applied elsewhere, the relevance of these features (along with parameter estimates in Appendix B) would need to be considered.

### Measures

For this analysis, the model outputs that have been used to compare different scenarios are: the number of incidents of verbal aggression among OU and IC residents inside public and private venues; the number of OU and IC residents ejected from public venues for being intoxicated; the percentage of OU and IC residents experiencing verbal aggression (noting that these can also occur outside of venues) and consumption-related harms; and the percentage of OU and IC residents experiencing transport-related harms. For each policy scenario being tested, 1000 simulations were run and average outputs were used to account for stochastic model variation. The modelled population for this analysis was 50% male, 50% IC residents (versus 50% OU residents) and 50% 18-21 year olds (versus 50% 22-25 year olds).

### Scenarios

To implement a policy of 24-hour PT it was assumed that the model parameter determining PT cut-off time was greater than the model run time. To implement a policy of 1am venue lockouts, agents moving between venues after this time no longer had the option to go to IC public venues. In a separate scenario, both 24-hour PT and 1am lockouts were implemented together.



### Sensitivity analysis

Alternate scenarios were run to compare outcomes when: PT was extended by only two hours instead of operating all night; venue lockouts occurred at 3am rather than 1am; and the combinations of a two-hour PT extension with 3am venue lockouts, and 24-hour PT with 3am venue lockouts.

### **Results**

Using baseline parameters, IC residents in the model were more likely to be involved in verbal aggression or ejected from public venues than OU residents, and less likely to be involved in verbal aggression in private venues (Table 1 and Figure 1); however, this is a reflection of IC residents spending more time in public venues (Scott, et al., 2015) rather than IC residents having a higher propensity for harm overall. When weighted by the numbers attending each venue type, the overall modelled prevalence of experiencing verbal aggression was very similar among IC and OU residents (6.36% versus 6.09% for IC and OU residents respectively). IC residents had a slightly lower prevalence of consumption-related harms than OU residents (13.25% versus 13.43%) and a slightly lower prevalence of transport-related harms than OU residents (5.41% versus 5.72%).

When implemented in the model, a policy of 24-hour PT had much more significant effects on OU residents in public venues than IC residents in public venues, as might be expected. Overall, the prevalence of experiencing verbal aggression decreased by 21% when 24-hour PT was available, owing largely to people no longer spending time on the street or in taxi ranks waiting to get home. However, the increased accessibility of public venues in the model resulted in OU residents spending

more time in the IC, leading to the displacement of some incidents of verbal aggression from OU private to IC public venues: the number of verbal aggression incidents among OU residents inside public venues increased by 34%, and decreased in private venues by 25%. Further, this coincided with a 70% increase in the number of OU residents being ejected from public venues for being intoxicated (the model does not include being ejected for other reasons (Brands, van Aalst, & Schwanen, 2015)).

A policy of 1am venue lockouts had much more significant effects on IC residents than OU residents in the model. This policy caused IC residents, who, unlike OU residents, were previously able to move from private to public venues late at night (OU residents did not do this once PT had stopped), to spend more time in private venues where the risk of experiencing verbal aggression was lower. With 1am lockouts in place there was a 49% reduction in the number of IC residents being ejected from public venues and a 25% reduction in the number of verbal aggression incidents involving IC residents inside public venues, with no apparent displacement. As drinking rates were modelled to be faster in private venues—which studies suggest occurs due to convenience and lower costs (Foster, Read, Karunanithi, & Woodward, 2010) —the additional time spent in private venues also explains the increased prevalence of consumption-related harms observed among IC residents. For both IC and OU residents, this policy reduced the overall prevalence of experiencing verbal aggression, led to increases in the prevalence of consumption-related harms and reduced transport-related harms by more than a third (35%).

The combination of 24-hour PT and 1am lockouts in the model reduced the prevalence of experiencing verbal aggression by 25%—more than either policy alone—but led to increased consumption-related harms among both OU and IC residents. For OU residents, these changes were

largely driven by the 24-hour PT policy on its own, but with a much smaller displacement of verbal aggression from private to public venues due to the restricted flow of people from OU areas to the IC late at night. For IC residents, these changes were largely driven by, and very similar to, the 1am lockout policy alone.

<Table 1>

### Sensitivity analysis

Similar results were found when a two-hour extension of PT was modelled instead of 24-hour PT (Table 2 and Figure 1). In particular, the overall reduction in the prevalence of experiencing verbal aggression was the same (22%), there were substantial reductions in the prevalence of experiencing transport-related harms (a decrease of 82%), and fewer incidents of verbal aggression among OU residents were displaced from private to public venues was smaller.

The model showed a policy of 3am lockouts to be less than half as effective as 1am venue lockouts in reducing the overall prevalence of experiencing verbal aggression (a decrease of 8% versus a decrease of 19% for 1am lockouts), but when implemented in combination with either 24-hour PT or a two-hour extension of PT produced similar results to a 1am lockout with 24-hour PT.

<Table 2>

<Figure 1>

## Discussion

This study takes the novel approach of using a simulation model of a single drinking occasion to implement and compare time-specific alcohol policies. Using an existing ABM we simulate a population of young heavy drinkers in Melbourne in order to virtually implement and compare the effects of PT extensions and venue lockout policies on verbal aggression, consumption-related harms and transport-related harms. Further, although the setting was specified as Melbourne, the results apply more broadly to places with centralised entertainment precincts that are popular among young adults.

The model predicts that a policy of 24-hour PT would be effective in reducing the prevalence of experiencing verbal aggression, with small concurrent reductions in consumption-related harms, but may lead to the displacement of some verbal aggression incidents among OU residents from private to public venues. However, an extension of PT operations by two hours had similar overall effects with fewer incidents of verbal aggression displaced, and was able to reduce 82% of transport-related harms. Given the high cost of operating 24-hour PT, the model suggests that this option would be worth exploring further.

A policy of 1am lockouts reduced the overall prevalence of experiencing verbal aggression in the simulation by 19%, slightly less than the 21% reduction under a policy of 24-hour PT, but also resulted in some increased consumption-related harms due to many IC residents being displaced from public venues to private venues where they drank faster and consumed a greater amount of alcohol. This modelled decrease in verbal aggression is roughly consistent with recent observations from Sydney, where the introduction of a 1.30am lockout in Kings Cross and the CBD resulted in a

26-32% decrease in assaults (Menéndez, et al., 2015), and an evaluation of the 2am venue lockouts in Melbourne, which suggested that assaults were down by 5-36% (Department of Justice, 2008); although the lack of data informing both evaluations makes this comparison tenuous. Nevertheless, this policy was also effective in decreasing transport-related harms among both IC and OU residents, with a reduction across the overall sample of 32%. When the lockout time was changed from 1am to 3am the policy was only approximately half as effective in reducing verbal aggression and transport-related harms.

The comparison of the modelled effects of the PT and venue lockout policies on their own support the suggestion that enabling policies can be similarly effective to restrictive ones, but without the economic and cultural downsides of restrictions (Department of Justice, 2008). For Melbourne, the model suggested that an enabling policy such as 24-hour PT—or even a two-hour extension in PT operations—may be more beneficial than a restrictive policy such as 1am venue lockouts, and even more beneficial than a policy of 3am lockouts. Such policies have a far greater chance of success, and face fewer cultural and political barriers in their implementation (Brands, et al., 2015; Lam, et al., 2015; Waitt, Jessop, & Gorman-Murray, 2011). The model has thus provided a demonstration that alternatives to tried policies, which might be more in line with the preferences and understandings of safety held by night-time economy patrons themselves, can be equally successful.

When implemented in combination, the modelled effects of 24 hour PT and 1am lockouts were roughly cumulative, since the individual policies disproportionately affected OU and IC residents respectively. However, when the venue lockout time was changed from 1am to 3am in the combined scenario, or when 24-hour PT was changed to a two-hour extension of PT, similar effects were observed. This is important, as implementing a 3am lockout policy is likely to have less cultural

opposition (Lam, et al., 2015) and extending PT by only two hours is considerably less expensive than implementing 24-hour operations. Our model suggests that similar overall outcomes could be achieved in terms of reductions in verbal aggression, consumption-related harms and transport-related harms.

This study has several limitations. First, these estimates are based on a theoretical model and there is uncertainty in the model parameters. In particular, limited studies were available that could be used to estimate many of the parameters (see Appendix B for a list of parameters and their sources), including the gender and socio-demographic distributions of harms (Brands, et al., 2015; Waitt, et al., 2011). Importantly, the key parameters governing agents' decisions to change venues or settings or to stop drinking were derived from relatively crude survey data, and further research into how policy affects these decisions is necessary. However, one-way sensitivity analyses and Latin Hypercube uncertainty experiments indicated that the model outcomes were robust when one or more of these parameters varied within their plausible ranges (Scott, et al., 2015). Second, baseline outcomes for the prevalence of consumption-related harms and transport-related harms have not been calibrated to data, since we could not identify any suitable studies. As a result, we emphasize that modelled outcomes should not be used to directly estimate the prevalence of these harms under individual policies, rather to compare multiple policy options as we have done. Third, as the model simulates a single drinking occasion, it only captures the immediate response to changes in alcohol policy and is unable to evaluate longer term behavioural changes as the population adapts to policies. This could potentially be addressed with further work, allowing agents to modify their behaviour and characteristics according to past experiences. Finally, several important lines of inquiry were beyond the scope of the model and the available data. For example, we were unable to investigate the perpetrators of verbal aggression (only the incidents experienced), or the implications of displacing incidents among OU residents from private to public venues. Further

ethnographic research should be undertaken to determine how interactions with security staff or an altered environment of social interactions affects this sub-population. We were also unable to investigate the possible effects of increased time spent in private venues on other forms of harm such as sexual assault. Future research and policy debate on reducing harm in the night-time economy should include careful consideration of such displacement effects.

## **Conclusion**

Our model suggests that a two-hour extension of PT is likely to be more effective in reducing verbal aggression and consumption-related harms than venue lockouts. Modelling a further extension of PT to 24 hours had minimal additional benefits and the potential to displace incidents of verbal aggression among OU residents from private to public venues. When implemented in conjunction with any extension of PT, 3am lockouts were equally as effective as 1am lockouts in reducing verbal aggression.

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## Tables

**Table 1, policies of 24 hour public transport (PT), 1am venue lockouts, and both.** Changes in the number of verbal aggression incidents in public and private venues; the number of people ejected from public venues; and the prevalence of experiencing verbal aggression, consumption-related harms and transport-related harms. Disaggregated for Inner City (IC) residents, Outer Urban (OU) residents and the entire model population.

	<i>Baseline (average number of incidents per 1000 population)</i>	<b>24 hour PT (% change from baseline)</b>	<b>1am lockout (% change from baseline)</b>	<b>1am lockout 24 hour PT (% change from baseline)</b>
Verbal aggression in public venue	15.67	+10%	-16%	-11%
Verbal aggression in public venue (OU)	12.32	+34%	-2%	+5%
Verbal aggression in public venue (IC)	19.03	-5%	-25%	-21%
Verbal aggression in private venue	39.96	-18%	-11%	-17%
Verbal aggression in private venue (OU)	44.15	-25%	-18%	-23%
Verbal aggression in private venue (IC)	35.75	-10%	-2%	-10%
Ejected from public venue	4.68	+25%	-39%	-9%
Ejected from public venue (OU)	2.93	+70%	-17%	+16%
Ejected from public venue (IC)	6.43	+4%	-49%	-21%
	<i>Baseline (average prevalence)</i>	<b>24 hour PT (% change from baseline)</b>	<b>1am lockout (% change from baseline)</b>	<b>1am lockout 24 hour PT (% change from baseline)</b>
Verbal aggression	6.23	-21%	-19%	-25%
Verbal aggression (OU)	6.09	-20%	-18%	-24%
Verbal aggression (IC)	6.36	-22%	-21%	-27%
Consumption-related harms (all)	13.33	-2%	5%	7%
Consumption-related harms (OU)	13.43	-6%	2%	4%
Consumption-related harms (IC)	13.25	2%	8%	10%
Transport-related harms (all)	5.56	N/A	-35%	N/A
Transport-related harms (OU)	5.72	N/A	-18%	N/A
Transport-related harms (IC)	5.41	N/A	-52%	N/A

**Table 2, policies of a two-hour public transport (PT) extension, 3am venue lockouts, both, and 3am venue lockouts with 24 hour PT.** Changes in the number of verbal aggression incidents in public and private venues; the number of people ejected from public venues; and the prevalence of experiencing verbal aggression, consumption-related harms and transport-related harms. Disaggregated for Inner City (IC) residents, Outer Urban (OU) residents and the entire model population.

	<i>Baseline (average number of incidents per 1000 population)</i>	<i>Two-hour PT extension (% change from baseline)</i>	<i>3am lockout (% change from baseline)</i>	<i>3am lockout two-hour PT extension (% change from baseline)</i>	<i>3am lockout 24 hour PT (% change from baseline)</i>
Verbal aggression in public venue	15.67	+5%	-8%	+2%	0%
Verbal aggression in public venue (OU)	12.32	+21%	+1%	+21%	+20%
Verbal aggression in public venue (IC)	19.03	-6%	-13%	-11%	-13%
Verbal aggression in private venue	39.96	-19%	-2%	-19%	-18%
Verbal aggression in private venue (OU)	44.15	-24%	-6%	-25%	-25%
Verbal aggression in private venue (IC)	35.75	-13%	3%	-11%	-10%
Ejected from public venue	4.68	+14%	-31%	+5%	+5%
Ejected from public venue (OU)	2.93	+37%	-17%	+39%	+43%
Ejected from public venue (IC)	6.43	+3%	-37%	-10%	-12%
	<i>Baseline (average prevalence)</i>	<i>Two-hour PT extension (% change from baseline)</i>	<i>3am lockout (% change from baseline)</i>	<i>3am lockout two-hour PT extension (% change from baseline)</i>	<i>3am lockout 24 hour PT (% change from baseline)</i>
Verbal aggression	6.23	-22%	-8%	-23%	-23%
Verbal aggression (OU)	6.09	-21%	-6%	-22%	-22%
Verbal aggression (IC)	6.36	-24%	-10%	-24%	-25%
Consumption-related harms (all)	13.33	-1%	+1%	0%	+1%
Consumption-related harms (OU)	13.43	-3%	0%	-4%	-2%
Consumption-related harms (IC)	13.25	+1%	+2%	+4%	+5%
Transport-related harms (all)	5.56	-82%	-16%	-85%	N/A
Transport-related harms (OU)	5.72	-79%	-6%	-79%	N/A
Transport-related harms (IC)	5.41	-86%	-26%	-92%	N/A

## Figures

**Figure 1: Results of simulating various public transport (PT) and venue lockdown policies.** The modelled number of incidents of verbal aggression in public venues, verbal aggression in private venues, and people being ejected from public venues among Inner City (IC) residents (left), Outer Urban (OU) residents (right).

