

Did the association between alcohol outlet density and crime change during COVID shelter-in-place orders?

Sharon E. O'Hara^{1,2}  | Mallie J. Paschall¹ | Joel W. Grube^{1,2}  | William R. Ponicki¹

¹Prevention Research Center, Berkeley, USA

²School of Public Health, University of California, Berkeley, Berkeley, USA

Correspondence

Sharon E. O'Hara, Prevention Research Center, 2030 Addison St., Suite 410, Berkeley, CA 94704-2642, USA.
Email: seohara@berkeley.edu

Funding information

National Institute on Alcohol Abuse and Alcoholism, Grant/Award Numbers: P60AA006282, T32AA014125

Abstract

Introduction: We investigated whether greater concentrations of on- and off-sale alcohol outlets were associated with crime and whether this association was moderated by COVID-19 shelter-in-place orders (SIP) that restricted on-premises consumption of alcohol.

Methods: Crimes (2019–2020) and addresses of licenced alcohol outlets in a medium-sized California city were geocoded within census block groups ($N = 61$). On- and off-sale alcohol outlet density was calculated as licenced outlets/2.59 km² (1 square mile). Multilevel negative binomial regression analyses were conducted to examine associations between alcohol outlet density and crime, and possible moderating effects of SIP, controlling for block group demographic characteristics and density of other retail businesses.

Results: On-sale outlet density was positively associated with total crimes and Part 2 crimes, while off-sale outlet density was inversely associated with total crime and Part 2 crimes. Overall, SIP was not significantly associated with crime, but moderated the associations of on-sale density with total crime and Part 1 crimes such that reductions in crime during SIP were observed in higher density areas. The association of off-sale outlets with crime was not moderated by SIP policies.

Discussion and Conclusion: On-sale outlet density, but not off-sale density, appears to be associated with increased crime. The results further indicate that restrictions in hours and service imposed by SIP policies reduced crime in high on-sale outlet density areas. These findings reinforce the importance of regulating alcohol outlet density and hours of service, especially for on-sale outlets, as a crime reduction strategy.

KEYWORDS

alcohol outlets, COVID-19, crime, on-premises density, shelter-in-place

Key Points

- On-sale alcohol outlet density was significantly and positively associated with more total crimes and Part 1 crimes.

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2024 The Authors. *Drug and Alcohol Review* published by John Wiley & Sons Australia, Ltd on behalf of Australasian Professional Society on Alcohol and other Drugs.

- Shelter-in-place orders moderated the associations of on-sale outlet density with crime such that there were reductions in total and Part 1 crimes in higher on-sale outlet density areas when shelter-in-place restrictions were in place.
- Our primary hypothesis was supported in that the association between on-sale density and crime was affected by the changes (e.g., temporary closures or restrictions on allowing patrons on the premises) in the operation of on-sale establishments during Los Angeles County's shelter-in-place orders.
- These findings are consistent with previous studies on the relationships between on-sale alcohol outlet density and sales restrictions with crime and reinforce prevention efforts that include restrictions on the number of outlets and hours of sale.

1 | INTRODUCTION

A large body of research links the spatial distribution of licenced alcohol establishments with crimes. In the United States, for example, a Camden, New Jersey study found that areas with high densities of on- and off-sale alcohol outlets had more violent crime and that alcohol outlet density increased violent crime within the same census block group but not in surrounding neighbourhoods [1]. Findings from another study in Philadelphia, Pennsylvania showed that the level of violence was highest within 85 feet of any bar, beyond which crime levels rapidly decreased [2]. Two other studies of alcohol outlet density and crime in the northeastern United States indicated that alcohol outlet density was related to increased violent crime and police calls for service [3, 4]. A study of the built environment in Seattle, Washington, found that a greater concentration of bars was positively associated with burglary, auto theft, arson and other types of theft [5]. Additionally, density of alcohol outlets/bars has been found to be significantly related to child maltreatment [6].

Similar results have been found in studies conducted outside the United States. Results of a study in Valencia, Spain, suggest that a higher density of bars in a neighbourhood was associated with more police calls for service [7]. In Ontario, Canada, both on-sale and off-sale alcohol outlets were found to be associated with higher levels of violent crime within commercial areas [8]. In New Zealand, alcohol outlet density and violent crime have also been found to be significantly associated regardless of licence type [9]. A longitudinal study in Melbourne, Australia found significant positive associations between crime and density of on-sale establishments, and an especially large effect of the association between off-sale licence types and violent crime [10]. A study in New Zealand estimated that each additional bar or night club was associated with 5.3 additional violent events per year and each additional licenced club (e.g., sports club) was associated with 0.8 additional

violent events per year [11]. Based on the research evidence, the World Health Organization, the US Centers for Disease Control and Prevention, and researchers from many countries recommend limiting alcohol outlet density as one way to reduce alcohol consumption and related harms, including community and social problems [12–14] and violence [15, 16].

Research also shows that restricting sales hours for alcoholic beverages may reduce crime. For example, a study in Australia found a 31% reduction in assaults after closing hours were reduced in Newcastle, New South Wales [17]. This reduction was sustained up to 7 years after the restrictions were first implemented [18, 19]. Studies in New Zealand similarly have found that restricting late night trading hours for both on- and off-sales outlets was associated with reductions in nighttime assaults [20, 21]. Although a study in Australia found evidence that trading hour restrictions in hospitality districts might shift some assaults to adjacent neighbourhoods [22], other studies have found no displacement as a result of such policies [23]. A recent study found that restrictions on sales hours significantly moderated the association between the density of high-risk outlets and assault [24]. Specifically, the association between density and crime was stronger when hours of sale ended at 5 AM as opposed to 3 AM.

An important unresolved question is why crime is associated with alcohol outlet densities and sales hours. According to alcohol availability theory, easier access to alcohol leads to greater consumption and alcohol-related problems, including crime [25]. Alternatively, alcohol outlets may provide a unique environment (e.g., late night hours, lack of sufficient security, poor exterior lighting) that enables criminal activity. Routine activity theory proposes that crime occurs when likely offenders and potential victims interact in a setting that lacks capable guardians such as police or security personnel [26]. According to routine activity theory it is not necessarily alcohol sales, consumption or outlets, but the broader unmonitored environment around alcohol outlets that

creates opportunities for crime to occur, although alcohol has been characterised within the routine activity theory framework as a 'chemical facilitator' of crime that increases the motivation of potential perpetrators and the vulnerability of potential victims [27].

Another explanation is that alcohol outlets selectively locate in areas of higher commercial density that attract relatively large numbers of people and thus provide greater opportunities for crime, regardless of the presence of alcohol outlets. Previous studies have examined whether the associations of alcohol outlets with crime are spurious and a matter of retail outlet density generally, rather than alcohol outlet density, by controlling for other retail geography. These studies show that alcohol outlet density is uniquely associated with crime even after controlling for other retail activity [28, 29]. Research also shows that outlets tend to aggregate in under-resourced areas of disadvantage (e.g., low-income, low rent neighbourhoods) that may be more susceptible to crime [30, 31]. Importantly, however, increases in outlet densities have been associated with increases in crimes in longitudinal studies, suggesting these associations are not entirely the result of outlets selectively locating in high crime areas [32, 33]. In a recent study, for example, it was estimated that each bar/pub opening within a neighbourhood was associated with a 3.5% increase in assaults and a 6.9% increase in robberies, after covarying for neighbourhood characteristics and overall outlet densities [34].

Although most studies have focused on policies that are specifically designed to reduce availability of alcohol and associated problems by restricting hours or places of sale for alcohol, it is possible that other social policies may affect crimes associated with alcohol outlets. Recent restrictions on commercial activities in response to the COVID-19 pandemic, for example, may have affected how much and where people drink, reducing alcohol consumption and shifting it away from on-sales establishment. These policies may also affect the broader environment around alcohol outlets by reducing the numbers of people who are present in those areas, thus decreasing opportunities for crime. In a recent study, alcohol-specific restrictions implemented in response to the COVID-19 pandemic in British Columbia, Canada were associated with reduced per capita alcohol sales, particularly for on-sales establishments where the most restrictive policies were associated with a 100% decrease in sales [35]. Another study conducted in Detroit, Michigan investigated associations between visits to bars and liquor stores and domestic and non-domestic assaults before and after the COVID pandemic. Analyses indicated greater decreases in visits to bars, compared to liquor stores, after the pandemic began, indicating more people were

obtaining alcohol at off-sale versus on-sale establishments. No significant associations were found between visits to bars and liquor stores and police calls for domestic assaults before COVID, but positive associations were found after the pandemic began. In contrast, visits to bars and liquor stores were positively associated with non-domestic assaults during pre-COVID months, but these relationships were no longer present after the pandemic began. These findings suggest that the COVID pandemic may have contributed to an increase in take-away alcohol purchases and consumption in households and to increases in domestic assaults but did not contribute to assaults and violence in general [36]. Another recent study in Copenhagen, Denmark, found that COVID-19 restrictions on the nightlife economy reduced violent crime, especially in high outlet density areas [37]. Taken together, the evidence suggests that restrictions on the sales of alcohol resulting from COVID shelter-in-place (SIP) policies may have reduced alcohol-related crime, especially in areas with high concentrations of outlets. Overall, however, few studies have investigated how outlet densities and sales restrictions might interact to impact crime rates, especially for crimes other than assaults. The current study sought to extend the available research by investigating the association between alcohol outlets and crime before, during and after the COVID SIP period that restricted on-premises consumption of alcohol in a medium-sized city in Los Angeles County, CA, USA while accounting for demographics and other retail business density.

In March 2020, state and local policies were enacted in response to the coronavirus pandemic that potentially affected the availability of alcohol in California. First, the governor issued a SIP or stay-at-home order to prevent the spread of infection [38]. Next, the Los Angeles County Public Health Officer ordered the closure of certain businesses, including bars and nightclubs that do not serve food, and restricted food-serving establishments to outdoor dining, curbside service, or home delivery. Specifically excluded from this order were '... sites and situations where people obtain essential services and essential goods to meet their basic needs, such as ... [g]rocery stores or retail stores' [39]. Because California has privatised alcohol sales, most grocery stores and supermarkets sell alcohol. Finally, that month, the California Department of Alcoholic Beverage Control issued the first of several 'Notices of Regulatory Relief', which granted 'temporary' additional privileges to licenced alcohol establishments. For example, the California Department of Alcoholic Beverage Control allowed off-sale premises to sell alcoholic beverages to persons in a motor vehicle or to persons outside the licenced premises (curbside sales). On-sale alcohol outlets were allowed to

sell alcoholic beverages to-go and deliver alcohol to homes, while consumption of alcohol on the licenced premises was prohibited or restricted [40]. To the extent that the association of crime with on-sale outlet density is the result of on-premises alcohol consumption or increased opportunities for crime around these outlets, SIP should reduce this relationship. The COVID SIP order from mid-March to early October 2020 thus provided an opportunity for a natural experiment to examine whether SIP restrictions were associated with a reduction in crimes occurring near licenced alcohol establishments in general and on-sale establishments in particular.

In this study, we investigated the associations of alcohol outlet density and SIP restrictions with crime. Although available studies provide important insights into how the COVID pandemic affected where people consume alcohol and context-related harms, they did not examine whether the SIP restrictions affected non-violent crimes in the vicinity of alcohol outlets as well as violent crimes. Whether placing restrictions on on-premises consumption of alcohol during the pandemic affected crime more generally in the vicinity of on- and off-sale outlets is not known.

Based on the literature and theoretical considerations, we hypothesised that crime would be positively related to alcohol outlet density within census block groups and inversely related to SIP restrictions. Although the research findings regarding associations of outlet types with crime are mixed [41], we expected the positive associations between outlet density and nearby crime to be stronger for on-sale than for off-sale outlets. We also hypothesised that SIP restrictions would moderate the associations between on-sale alcohol outlet density and crime, such that there would be fewer crimes in the vicinity of on-sale alcohol outlets during the time covered by the Los Angeles County Health Department's COVID SIP orders due to substantially less alcohol consumption at these establishments. We did not expect to observe this moderating effect for off-sale outlets, given they were not affected by the SIP restrictions and there was only take-away alcohol at these establishments. We also expected that the greatest reductions in crime would occur in higher-density areas. This hypothesis is based on previous research showing that closing hours restrictions had greater effects on assaults for high-risk outlets [24] and on the study of SIP restrictions and violent crime in the entertainment districts in Copenhagen, Denmark [37]. These hypotheses are further grounded in availability theory, which suggests that on-premises alcohol consumption has an effect on crime perpetration and victimisation apart from routine activities and other environmental factors related to a higher concentration of alcohol outlets and other retail businesses in the same areas.

2 | METHODS

2.1 | Sample

The sample for this study consisted of 61 census block groups in the city of Palmdale, located in the northern portion of Los Angeles County, California. The city was selected because the primary author (S.E.O.) was approached by a local community-based organisation interested in the relationship between alcohol outlet density and crime in their city. Palmdale covers approximately 274.69 km² (106.06 square miles), with a 2020 population of 169,913 [41]. We used data from the US Census to identify block groups as the units of analysis. The final sample of 61 block groups ranged in population from 171 to 7190 (M [SD] = 2661 [1426]).

2.2 | Measures

We used data from five sources: (i) publicly available crime data from the Los Angeles County Sheriff's Palmdale Station by address [42]; (ii) addresses of active licenced alcohol establishments from the California Department of Alcoholic Beverage Control for 2019–2020 [43]; (iii) addresses of other selected licenced retail businesses in the City of Palmdale [44]; (iv) sociodemographic data from the United States Census Bureau [45]; and (v) dates of COVID-19 SIP orders from the Los Angeles County Public Health Department were in place [46].

2.2.1 | Crimes

The dependent measure was the number of crimes handled by the Palmdale Sheriff's Station over the study period (2019–2020). First, we obtained publicly available data from the Palmdale Sheriff's Station about all Part 1 and Part 2 crimes by address. This included calls for service that reported crimes, arrest records and crime reports initiated by Sheriff's deputies. We then filtered the dataset to include all Part 1 crimes and selected Part 2 crimes that were committed within the city limits during the study period. Part 1 crime categories were criminal homicide, forcible rape, robbery, aggravated assault, burglary, larceny theft, grand theft auto and arson. Selected Part 2 crime categories included sex offences (felony and misdemeanor), non-aggravated assaults, weapons, offences against family, narcotics, under the influence of alcohol/drugs, drunk in public, drunk driving (vehicle/boat), vandalism, miscellaneous felonies and miscellaneous misdemeanours. We successfully geocoded 92.6% of the crimes. The total number of observations

was 488, representing quarterly crime counts collected for the 61 Palmdale census block groups over 2 years.

2.2.2 | Alcohol outlet density

We obtained the names, addresses and licence types for all alcohol establishments in the city of Palmdale from the California Department of Alcoholic Beverage Control website. The alcohol outlets included in the study were only those with on-sale and/or off-sale retail sales to the public, such as bars, restaurants, grocery stores, supermarkets and corner (package) stores. As California has a privatised alcohol sales system, all such businesses are licenced by the state but owned and operated by private parties. Outlet density was calculated as the number of on-sale and off-sale licenced alcohol establishments per 2.59 km² (1 square mile) within each block group. On-sale alcohol outlet density among the block groups ranged from 0.00 to 28.00, and off-sale alcohol outlet density ranged from 0.00 to 15.87.

2.2.3 | Other retail outlets

Following the rationale of a New Zealand study, other retail businesses consisted of three groups: (i) bakeries, coffee shops and cafés; (ii) barber shops and beauty (hair, nail) salons; and (iii) fast food restaurants (without alcohol sales) and food vehicles [28]. Gas stations were also included as retail businesses in the New Zealand study, but in California virtually all gas stations have licences to sell alcohol for consumption off the premises and thus are included in the number and density of off-sale alcohol outlets. The three groups were combined, and 'other retail outlet density' was calculated as the number of such businesses per 2.59 km² (1 square mile) within each block group.

2.2.4 | Socio-demographic characteristics

Block group socio-demographic characteristics were obtained from the US Census Bureau's American Community Survey data for the United States [44]. These data included the total population and the percent of the population within the following categories of race and ethnicity: Hispanic, and the non-Hispanic categories of American Indian/Alaska Native, Asian, Black, mixed, Pacific Islander, White and unknown. Indicators of socioeconomic status were percent of population with a college bachelor's degree and median household income.

2.2.5 | Time

Time was coded as 1–8, corresponding to the eight 3-month periods (quarters) from January 2019 to December 2020.

2.2.6 | COVID-19 shelter-in-place

A categorical variable was created to represent COVID-19 SIP restrictions. This variable represented the percentage of days in each quarter that on-sale outlets were asked to close temporarily or limit sales to outdoor dining or curbside or home delivery only. The SIP variable was coded zero when no days per quarter were under SIP restrictions, 1 when 5.0–18% of days were under restriction, and 2 when 90% or more days were under SIP restriction. All of the observations fell within these mutually exclusive categories. Given the distribution of SIP days (i.e., no quarters fell between 19% and 89%), it was not reasonable to treat SIP as a continuous variable.

2.3 | Analyses

First, we used geographic information system (GIS) technology to visualise crime in relation to licenced alcohol establishments in Palmdale, California during the years 2019 and 2020. We then conducted multi-level negative binomial regression analyses to examine associations between on- and off-sale alcohol outlet density and crime and test the interactions between SIP restrictions and density.

2.3.1 | GIS analysis

Using ESRI's GIS software [47], we created interactive maps to observe the locations of crimes and the locations and density of licenced on-sale and off-sale alcohol establishments and selected other retail businesses per 2.59 km² (1 square mile). Using the data received from the Palmdale Sheriff's station, each crime point was geocoded and spatially joined to census block groups using ArcGIS Pro and ArcGIS Online to get a total number of crimes in each block group. We repeated this process for licenced on-sale and off-sale alcohol establishments and other selected retail establishments within the city's boundaries. Finally, all census block groups were enriched using Esri's GeoEnrichment tool for income, education and ethnicity/race.

2.3.2 | Multi-level regression analyses predicting the number of crimes by alcohol outlet density level

The primary analyses comprised a series of multilevel negative binomial regression models to examine the association of alcohol outlet density and total crimes, controlling for block group population and other demographic characteristics, other retail outlet density, SIP and time. In an initial model, crime was predicted from on-sale alcohol outlet density and off-sale density, other retail outlet density, time, SIP and block group demographic covariates. We then added the interactions between on-sale and off-sale density with SIP to the regression model. Non-significant interaction terms were dropped from the analysis. We conducted these analyses in Stata Statistical Software [48] to adjust standard errors for clustering of observations within census block groups. Spatial autocorrelation accounted for no more than 1% of the residual variance of crimes and thus was ignored in these models.

3 | RESULTS

3.1 | Descriptive statistics

Characteristics of the 61 Palmdale block groups are shown in Table 1. We found a high correlation between total alcohol outlet density and other retail outlet density

TABLE 1 Descriptive statistics for Palmdale block groups ($n = 61$).

Variable	Mean	SD	Min.	Max.
Total crime count	29.59	24.83	0.00	124.00
On-sale alcohol outlet density	1.98	4.61	0.00	28.00
Off-sale alcohol outlet density	2.14	3.28	0.00	15.87
Other retail outlet density	6.74	9.94	0.00	37.50
American Indian/Alaska Native (%)	0.86	0.39	0.10	2.02
Asian (%)	4.12	3.14	0.63	14.96
Black (%)	13.23	4.95	4.29	35.07
Native Hawaiian/Pacific Islander (%)	0.19	0.17	0.00	0.73
White (%)	46.62	9.16	23.72	76.07
Multi-racial (%)	5.92	1.20	3.43	9.04
Other race (%)	28.19	9.24	5.39	44.77
Hispanic/Latino (%)	58.49	14.99	19.1	79.17
Bachelor's degree or higher (%)	9.34	7.25	0.60	29.07
Median household income (100 K)	0.64	0.28	0.17	1.52
Population, 1 K	2.66	1.43	0.17	7.19

($r = 0.80$). More than half of the population was Latino/a (M [SD] 58.5 [16.3], range = 19.0–79.2).

3.2 | Results of multi-level negative binomial regression predicting total crimes, Part 1 crimes, and Part 2 crimes from on-sale and off-sale alcohol outlet density

Table 2 presents the incident rate ratios from negative binomial regression models predicting the total number of crimes, total number of Part 1 crimes and total number of Part 2 crimes. Column 2 indicates the total number of crimes predicted from on-sale and off-sale alcohol outlet density separately and indicates a significant association between total crimes and on-sale alcohol outlet density (incident rate ratio [IRR] = 1.04, $p = 0.02$) and a significant inverse relationship between total crimes and off-sale alcohol outlet density (IRR = 0.95, $p = 0.04$). On-sale density was also found to have a significant positive relationship with Part 1 crimes (IRR = 1.05, $p = 0.02$), while off-sale density had a significant inverse relationship with Part 2 crimes (IRR = 0.95, $p = 0.01$). Los Angeles County SIP orders overall were not found to be associated with total crimes, Part 1 crimes or Part 2 crimes. However, a significant interaction between on-sale density and full ($\geq 90\%$ of days) SIP implementation was found for total crimes (IRR = 0.98, $p = 0.00$) and Part 1 crimes (IRR = 0.98, $p = 0.03$), indicating there a decrease in the crime in higher density block groups for on-sale establishments during the time these businesses were subject to closure or restrictions because of SIP orders. The moderating effect of SIP with respect to low (0.0 outlets), medium (0.14–5.38 outlets) and high (6.11–28.0 outlets) on-sale outlet density levels is illustrated in Figure 1.

4 | DISCUSSION

This study capitalised on a natural experiment to investigate whether restrictions on on-premises alcohol sales and consumption during COVID SIP months reduced crimes in the vicinity of alcohol outlets. As expected, on-sale alcohol outlet density was positively associated with total and Part 1 crimes, although not with Part 2 crimes. Putting this into perspective, an increase of one on-sale outlet per 2.59 km² (1 square mile) was associated with an increase of four crimes overall and five Part 1 crimes over the 24 months of the study. Unexpectedly, off-sale outlet density was associated with lower numbers of crimes. Overall, SIP restrictions were not significantly

TABLE 2 Results of multilevel negative binomial regression analyses predicting total crimes, Part 1 crimes, and Part 2 crimes from alcohol outlet density and COVID-19 shelter in place restrictions, incident rate ratio (IRR), 95% confidence interval (CI).

Predictor	Model		
	Total crimes IRR (95% CI)	Part 1 crimes ^a IRR (95% CI)	Part 2 crimes ^b IRR (95% CI)
On-sale density	1.04 (1.01, 1.08)*	1.05 (1.01, 1.10)*	1.03 (0.99, 1.08)
Off-sale density	0.95 (0.91, 1.00)*	0.98 (0.92, 1.04)	0.95 (0.91, 0.99)*
Shelter-in-place (SIP) ^c			
Minimal	1.08 (0.92, 1.26)	1.11 (0.96, 1.28)	1.01 (0.81, 1.27)
Full	1.07 (0.94, 1.22)	1.04 (0.90, 1.20)	1.07 (0.89, 1.27)
On-sale density X SIP			
Minimal	0.98 (0.95, 1.00) [§]	1.00 (0.99, 1.00)	0.97 (0.93, 1.01) [§]
Full	0.98 (0.96, 0.99) ^{***}	0.98 (0.96, 1.00)*	0.98 (0.95, 1.00) [§]
Other retail density	1.02 (1.00, 1.04)*	1.02 (1.00, 1.04)	1.02 (1.01, 1.04) ^{**}
Race ^d			
% American Indian/Alaska Native	0.80 (0.54, 1.17)	0.71 (0.42, 1.21)	0.84 (0.61, 1.17)
% Asian	1.05 (0.99, 1.11)	1.05 (0.97, 1.14)	1.05 (1.00, 1.11)
% Black	1.00 (0.98, 1.02)	1.00 (0.95, 1.05)	1.00 (0.97, 1.02)
% Native Hawaiian/% Pacific Islander	0.52 (0.27, 1.00)*	0.46 (0.19, 1.12)	0.53 (0.29, 0.99)*
% Multi-racial	1.05 (0.96, 1.15)	1.04 (0.91, 1.19)	1.05 (0.96, 1.15)
% Other race	1.01 (0.97, 1.05)	1.00 (0.95, 1.06)	1.01 (0.97, 1.05)
% Hispanic/Latino(a)	0.99 (0.96, 1.01)	0.99 (0.95, 1.03)	0.98 (0.96, 1.01)
% At least Bachelor's degree	0.98 (0.94, 1.01)	0.96 (0.91, 1.02)	0.99 (0.95, 1.02)
Median HH income (100 K)	0.998 (0.997, 0.998) ^{***}	0.999 (0.997, 1.00)*	0.998 (0.997, 0.999) ^{***}
Population (1 K)	1.28 (1.18, 1.40) ^{***}	1.38 (1.23, 1.55) ^{***}	1.24 (1.14, 1.34) ^{***}
Time	1.02 (0.99, 1.05)	1.00 (0.97, 1.03)	1.03 (0.99, 1.08)

^aPart 1 crimes include criminal homicide, forcible rape, robbery, aggravated assault, burglary, larceny theft, grand theft auto and arson.

^bPart 2 crimes include sex offences (felony and misdemeanour), non-aggravated assaults, weapons, offences against family, narcotics, under the influence of alcohol/drugs, drunk in public, drunk driving (vehicle/boat), vandalism, miscellaneous felonies, and miscellaneous misdemeanours.

^cSIP was coded as 0 for quarters with no shelter in place restrictions, 1 (minimal) for quarters where restrictions were in place for $\leq 18\%$ of days, and 2 (full) when they were in place for $\geq 90\%$ of days. All quarters fell into one of these mutually exclusive categories. No restrictions is the reference category.

^dWhite is the reference group.

[§] $p < 0.10$.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

associated with decreases in crime. Consistent with our expectations, however, reductions in crime during were observed in areas with the highest density of on-sales outlets during quarters when SIP policies were fully in place, although these reductions were marginal for Part 2 crimes. SIP was not associated with changes in crime related to off-sales outlets, which were not targeted by these policies. Importantly, these findings were obtained when controlling for census block characteristics and density of other retail activity. They thus suggest that crimes occurring near on-sale establishments may be attributable to factors associated with the operation of

these businesses (e.g., levels of alcohol consumption, customer characteristics) rather than the broader retail environment surrounding them.

Our findings are similar to those of other studies that have found positive associations of on-sale alcohol outlets with crimes [11, 30, 33]. Our findings are also consistent with research showing reductions in crime associated with restrictions on alcohol sales and service [17–23]. Our findings also replicate those of previous studies showing that reductions in crime associated with alcohol-related policies are greater in higher outlet density areas [24, 37]. These latter studies, and ours, suggest

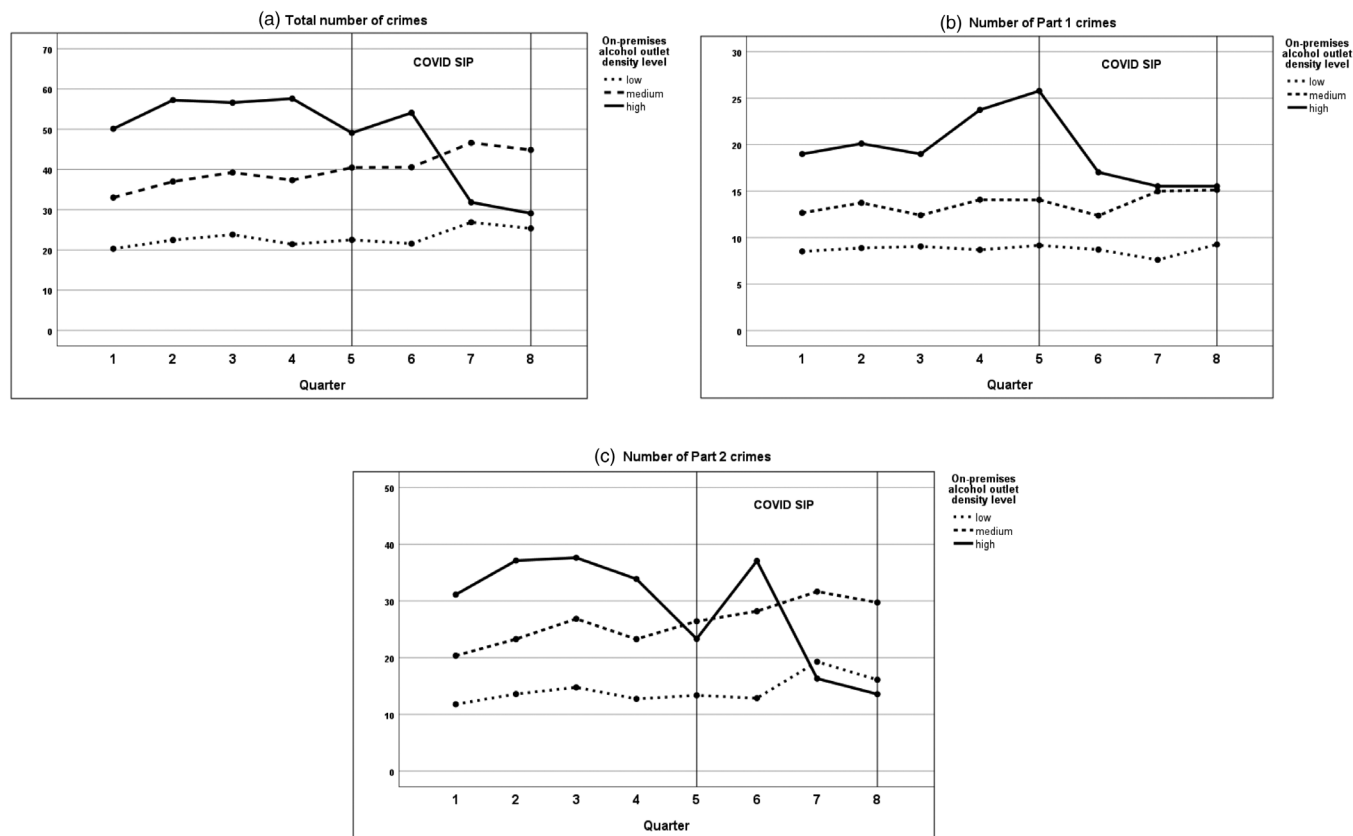


FIGURE 1 Trends in (a) the total number of crimes, (b) number of Part 1 crimes and (c) number of Part 2 crimes occurring in block groups with low (0.0), medium (0.14–5.38) and high (6.11–28.0) on-sale alcohol outlet density levels. The COVID shelter-in-place (SIP) orders began in the fifth quarter and ended in the eighth quarter of the study period with full SIP implementation during quarters 6 and 7.

that policies restricting alcohol sales may be more effective in reducing crime in high crime and high outlet density areas.

Unexpectedly, we found that density of off-sales outlets was inversely related to crime. Although the research is mixed [41], a number of studies have found positive associations between off-sale outlet densities and violent crime [8–10]. Our findings regarding off-sale outlets may have resulted from the broader definitions of crime used in our study. Unfortunately, we were not able to focus on specific types of crimes (e.g., assaults) given the limitations of our data. It may also be that crimes associated with on-sales outlets may be concentrated in nearby areas [2], whereas some crimes associated with off-sales outlets may be more dispersed to other locations outside of the area of purchase (e.g., home or home neighbourhood). There is also a diversity of off-sale outlets in California, including supermarkets, warehouse stores and gas stations, as well as liquor stores and smaller neighbourhood groceries. Some of these may be associated with nearby crime, while others are not. The type of off-sale outlet may be an important factor that should be considered in future research.

4.1 | Limitations

One limitation of this study is that it only includes data from one city over a 24-month period. Thus, a relatively few incidents of specific crimes, especially serious and violent crimes, were captured during the study period. This limited our ability to consider specific types of crimes, rather than broader categories (total, Part 1 and Part 2). In addition, the small number of units (census block groups) may have limited our statistical power, causing us to underestimate the statistical significance of some effects of SIP and outlet density. With only one city, we are also unable to compare the effects of COVID SIP on the association between alcohol outlet density and crime with other cities in Los Angeles County or California.

Because the county's SIP orders were of fairly short duration and possibly not well enforced, it is conceivable that at least some on-sale establishments did not close or modify their alcohol-serving practices during the SIP orders. On-sale outlets were also allowed to make take-away sales during SIP and may have been selling alcohol at outside tables, which may not have significantly

reduced consumption. Nonetheless, the fact that the SIP restrictions were associated with reductions in crimes in high-density areas despite the possibility they were not completely enforced strongly argues that the effects of such policies are robust.

We were unable to determine the extent to which on-sale outlets were serving alcohol on-site despite the county SIP order. Similarly, data on takeout sales are not available. This lack of information makes it difficult to draw definitive conclusions about whether the observed associations between on-sale outlet density and crime were related to changes in on-premises alcohol consumption or routine activities in the vicinity of alcohol outlets that persisted even when service was restricted.

5 | CONCLUSION

This study provides additional evidence for the importance of regulating alcohol outlet density and hours of sale to prevent community-level problems. Consistent with previous studies, density of on-sale alcohol outlets appears was associated with a greater risk of crime at the census block group level, controlling for block group population and demographic characteristics, other retail outlet density, and time. In line with our expectations, the association between higher on-sale outlet density and crimes was reduced during the fullest implementation of COVID SIP orders. Off-sale outlet density was inversely related to total crimes and Part 2 crimes within the same block groups. This latter finding deserves further research to determine why this was the case. Overall, the findings are consistent with previous studies on the relationship between alcohol outlet density and crime when hours of sale are reduced and reinforce prevention efforts that include restrictions on the number of outlets and hours of sale.

AUTHOR CONTRIBUTIONS

Sharon E. O'Hara made substantial contributions to the conception and design of the work and the acquisition, analysis and interpretation of data for the work. As the primary author, she drafted the work, revised it critically for important intellectual content and approved the version to be published. Mallie J. Paschall made substantial contributions to the conception and design of the work, analysis and interpretation of data for the work; revised the work critically for important intellectual content; and approved the version to be published. Joel W. Grube made substantial contributions to the conception and design of the work, analysis and interpretation of data for the work, revised the work critically for important intellectual content; and approved the version to be published. William R. Ponicki made substantial contributions to the work

including the use of ArcGIS software to map alcohol outlet locations provided by the California Alcohol Beverage Control agency as well as determining which Census block group polygons best approximate Palmdale's city boundaries and approved the version to be published. Each author certifies that their contribution to this work meets the standards of the International Committee of Medical Journal Editors.

ACKNOWLEDGEMENTS

The authors wish to thank Hena Osmani, Jesus Torres and Dr Charlotte Smith of the University of California, Berkeley School of Public Health for their assistance in the preparation of data and spatial analysis for this study. This research and preparation of this paper were supported by grants P60-AA006282 and T32-AA014125 from the National Institute on Alcohol Abuse and Alcoholism of the US National Institutes of Health. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute on Alcohol Abuse and Alcoholism or National Institutes of Health.

CONFLICT OF INTEREST STATEMENT

Dr O'Hara and Mr Ponicki have no conflicts to declare. Drs Paschall and Grube were supported in the past 3 years with funds from the AB InBev Foundation to conduct an independent evaluation of the Global Smart Drinking Goals initiative.

ETHICS STATEMENT

As this was an analysis of publicly available secondary data and involved no human subjects, no ethical approval was required.

ORCID

Sharon E. O'Hara  <https://orcid.org/0000-0002-2805-3070>

Joel W. Grube  <https://orcid.org/0000-0003-1099-8743>

REFERENCES

1. Gorman DM, Speer PW, Gruenewald PJ, Labouvie EW. Spatial dynamics of alcohol availability, neighborhood structure and violent crime. *J Stud Alcohol*. 2001;62:628–36.
2. Ratcliffe JH. The spatial extent of criminogenic places: a changepoint regression of violence around bars. *Geogr Anal*. 2012; 44:302–20.
3. Lardier DT, Opara I, Lin Y, Roach E, Herrera A, Garcia-Reid P, et al. A spatial analysis of alcohol outlet density type, abandoned properties, and police calls on aggravated assault rates in a northeastern U.S. city. *Subst Use Misuse*. 2021;56:1527–35.
4. Lardier DT, Reid RJ, Yu D, Garcia-Reid P. A spatial analysis of alcohol outlet density and abandoned properties on violent crime in Paterson New Jersey. *J Community Health*. 2020;45: 534–41.

5. Matthews SA, Yang TC, Hayslett KL, Ruback RB. Built environment and property crime in Seattle, 1998–2000: a Bayesian analysis. *Environ Plan A*. 2010;42:1403–20.
6. Freisthler B, Needell B, Gruenewald PJ. Is the physical availability of alcohol and illicit drugs related to neighborhood rates of child maltreatment? *Child Abuse Negl*. 2005;29:1049–60.
7. Marco M, Freisthler B, Gracia E, López-Quilez A, Lila M. Neighborhood characteristics, alcohol outlet density, and alcohol-related calls-for-service: a spatiotemporal analysis in a wet drinking country. *Int J Geo-Inf*. 2017;6:380.
8. Quick M, Law J, Luan H. The influence of on-premise and off-premise alcohol outlets on reported violent crime in the region of Waterloo, Ontario: applying Bayesian spatial modeling to inform land use planning and policy. *Appl Spatial Analysis*. 2017;10:435–54.
9. Day P, Breetzke G, Kingham S, Campbell M. Close proximity to alcohol outlets is associated with increased serious violent crime in New Zealand. *Aust N Z J Public Health*. 2012;36:48–54.
10. Livingston M. A longitudinal analysis of alcohol outlet density and domestic violence. *Addiction*. 2011;106:919–25.
11. Cameron MP, Cochrane W, Gordon C, Livingston M. Alcohol outlet density and violence: a geographically weighted regression approach. *Drug Alcohol Rev*. 2016;35:280–8.
12. Campbell CA, Hahn RA, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. The effectiveness of limiting alcohol outlet density as a means of reducing excessive alcohol consumption and alcohol-related harms. *Am J Prev Med*. 2009;37:556–69.
13. Livingston M. Alcohol outlet density and harm: comparing the impacts on violence and chronic harms. *Drug Alcohol Rev*. 2011;30:515–23.
14. Sacks JJ, Gonzales KR, Bouchery EE, Tomedi LE, Brewer RD. 2010 national and state costs of excessive alcohol consumption. *Am J Prev Med*. 2015;49:e73–9.
15. Trangenstein PJ, Eck RH, Lu Y, Webster D, Jennings JM, Latkin C, et al. The violence prevention potential of reducing alcohol outlet access in Baltimore, Maryland. *J Stud Alcohol Drugs*. 2020;81:24–33.
16. World Health Organization. Preventing Violence by Reducing the Availability and Harmful Use of Alcohol. Geneva, Switzerland: WHO; 2009. p. 16.
17. Kypri K, Jones C, McElduff P, Barker D. Effects of restricting pub closing times on night-time assaults in an Australian city. *Addiction*. 2011;106:303–10.
18. Kypri K, McElduff P, Miller P. Restrictions in pub closing times and lockouts in Newcastle, Australia five years on. *Drug Alcohol Rev*. 2014;33:323–6.
19. Kypri K, McElduff P, Miller P. Night-time assaults in Newcastle 6–7 years after trading hour restrictions. *Drug Alcohol Rev*. 2016;35:E1–2.
20. Connor J, MacLennan B, Huckle T, Romeo J, Davie G, Kypri K. Changes in the incidence of assault after restrictions on late-night alcohol sales in New Zealand: evaluation of a natural experiment using hospitalization and police data. *Addiction*. 2021;116:788–98.
21. Huckle T, Parker K, Mavoia S, Casswell S. Reduction in late-night violence following the Introduction of National New Zealand Trading Hour Restrictions. *Alcohol Clin Exp Res*. 2020;44:722–8.
22. Kypri K, Livingston M. Incidence of assault in Sydney, Australia, throughout 5 years of alcohol trading hour restrictions: controlled before-and-after study. *Addiction*. 2020;115:2045–54.
23. Menéndez P, Kypri K, Weatherburn D. The effect of liquor licensing restrictions on assault: a quasi-experimental study in Sydney, Australia. *Addiction*. 2017;112:261–8.
24. Taylor N, Livingston M, Coomber K, Mayshak R, Zahnow R, Ferris J, et al. The combined impact of higher-risk on-license venue outlet density and trading hours on serious assaults in night-time entertainment precincts. *Drug Alcohol Depend*. 2021;223:108720.
25. Gruenewald P, Millar A, Treno A. Alcohol availability and the ecology of drinking. *Alcohol Health Res World*. 1993;17:39–45.
26. Cohen LE, Felson M. Social change and crime rate trends: a routine activity approach. *Am Sociol Rev*. 1979;44:588–608.
27. Clarke RV, Eck JE. Crime analysis for problem solvers in 60 small steps. Washington, DC: US Department of Justice, Office of Community Oriented Policing Services [Internet]; 2005. Available from: <https://www.ojp.gov/ncjrs/virtual-library/abstracts/crime-analysis-problem-solvers-60-small-steps>
28. Cameron MP. The relationship between alcohol outlets and crime is not an artefact of retail geography. *Addiction*. 2022;117:2215–24.
29. Grubestic TH, Pridemore WA, Williams DA, Philip-Tabb L. Alcohol outlet density and violence: the role of risky retailers and alcohol-related expenditures. *Alcohol Alcohol*. 2013;48:613–9.
30. Gruenewald PJ, Freisthler B, Remer L, LaScala EA, Treno A. Ecological models of alcohol outlets and violent assaults: crime potentials and geospatial analysis. *Addiction*. 2006;101:666–77.
31. Mair C, Gruenewald PJ, Ponicki WR, Remer L. Varying impacts of alcohol outlet densities on violent assaults: explaining differences across neighborhoods. *J Stud Alcohol Drugs*. 2013;74:50–8.
32. Gruenewald PJ, Remer L. Changes in outlet densities affect violence rates. *Alcohol Clin Exp Res*. 2006;30:1184–93.
33. Livingston M. Alcohol outlet density and assault: a spatial analysis. *Addiction*. 2008;103:619–28.
34. Gruenewald PJ, Sumetsky N, Gaidus A, Ponicki W, Lee JP, Mair C. Assessing the impacts of alcohol outlets on crime as a natural experiment: agglomeration, churning and spatial effects. *Addiction*. 2022;117:2614–22.
35. Clay JM, Alam F, Zhao J, Churchill S, Naimi T, Stockwell T. Associations between COVID-19 alcohol policy restrictions and alcohol sales in British Columbia: variation by area-based deprivation level. *J Stud Alcohol Drugs*. 2023;84:424–33.
36. Chalfin A, Danagoulian S, Deza M. Covid-19 has strengthened the relationship between alcohol consumption and domestic violence [Internet]. Cambridge, Massachusetts, USA: National Bureau of Economic Research; 2021 Mar [cited 1 February 2023]. (Working Paper Series). Report No: 28523. Available from: <https://www.nber.org/papers/w28523>
37. Ejrnæs A, Scherg RH. Nightlife activity and crime: the impact of COVID-19 related nightlife restrictions on violent crime. *J Crim Justice*. 2022;79:101884.
38. State of California. Governor Gavin Newsom issues stay at home order [Internet]. Sacramento, California, USA: California Governor; 2020 [cited 1 February 2023]. Available from:

- <https://www.gov.ca.gov/2020/03/19/governor-gavin-newsom-issues-stay-at-home-order/>
39. County of Los Angeles Department of Public Health, Order of the Health Officer. Listing of Department of Public Health Press Releases [Internet]. [cited 1 February 2023]. Available from: <http://www.publichealth.lacounty.gov/phcommon/public/media/mediapubhpdetail.cfm?prid=2269>
 40. State of California. First Notice of Regulatory Relief | Alcoholic Beverage Control [Internet]. [cited 1 February 2023]. Available from: <https://www.abc.ca.gov/notice-of-regulatory-relief/>
 41. Fitterer JL, Nelson TA, Stockwell T. A review of existing studies reporting the negative effects of alcohol access and positive effects of alcohol control policies on interpersonal violence. *Front Public Health*. 2015;3:253. <https://doi.org/10.3389/fpubh.2015.00253/abstract>
 42. Los Angeles County Sheriff's Department. Part 1 and Part 2 Crimes Data [Internet]. [cited 11 January 2023]. Available from: <https://lasd.org/transparency/part1and2crimedata/>
 43. State of California, Alcoholic Beverage Control. Licenses by City [Internet]. [cited 11 January 2023]. Available from: <https://www.abc.ca.gov/licensing/licensing-reports/licenses-by-city/>
 44. City of Palmdale, CA. Business Search [Internet]. [cited 11 January 2023]. Available from: <https://palmdale.hdlgov.com/Search/Index/BusinessLicense>
 45. U.S. Census Bureau. American Community Survey 5-Year Data (2009–2021) [Internet]. Census.gov. [cited 26 January 2023]. Available from: <https://www.census.gov/data/developers/data-sets/acs-5year.html>
 46. Los Angeles County Department of Public Health. COVID-19 Media Page [Internet]. [cited 1 February 2023]. Available from: <http://publichealth.lacounty.gov/media/coronavirus/>
 47. ArcGIS Pro. Esri, Inc. 2022.
 48. StataCorp. Stata: release 17. Statistical software. College Station, TX: StataCorp LLC; 2021.

How to cite this article: O'Hara SE, Paschall MJ, Grube JW, Ponicki WR. Did the association between alcohol outlet density and crime change during COVID shelter-in-place orders? *Drug Alcohol Rev*. 2024. <https://doi.org/10.1111/dar.13807>