Drug and Alcohol Dependence 233 (2022) 109352

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Examining how the geographic availability of alcohol within residential neighborhoods, activity spaces, and destination nodes is related to alcohol use by parents of young children

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ARTICLE INFO

Keywords:
Alcohol outlet density
Activity spaces
Alcohol use
Parents

ABSTRACT

Background: Alcohol outlet density and drinking behaviors have been assessed based on where people live, but exposure may differ based on where people spend time. We assessed the relationship between alcohol outlet density (using three measures of geographic availability), frequency of use, and continued volume of alcohol among parents. Parents are a unique population of drinkers where the risk for harm to others can be higher as they are caring for minor children.

Methods: We conducted a cross-sectional telephone and web-based survey of 1599 parents in 2015 across 30 cities in California. Participants provided information on drinking, residential addresses, and locations of daily activities. We created three measures of alcohol availability using residential neighborhoods, convex hull polygons, and destination nodes. Data were analyzed using zero-inflated negative binomial models.

Results: Density of bars in residential neighborhoods were related to more frequent drinking ($b = 0.0139$, 95% CI $= 0.0016, 0.0261$) and higher continued volume ($b = 0.0295$, 95% CI $= 0.0067, 0.0522$). Density of bars ($b = 0.0070$, 95% CI $= 0.0019, 0.0121$) and restaurants ($b = 0.0018$, 95% CI $= 0.0003, 0.0033$) in destination nodes were related to drinking a higher continued volume of alcohol. Higher off-premise outlet density was related to a lower continued volume ($b = -0.0026$, 95% CI $= -0.0049, -0.0002$).

Conclusions: Outlet densities in residential neighborhood and destination nodes are related to frequency of drinking and continued volume of alcohol. Future work should seek to determine why and how residential neighborhoods and nodes are related to alcohol use behaviors and if they differ for parents compared to other adults.

1. Introduction

Excessive alcohol use remains a serious public health problem in the United States, costing society around $250 billion every year (Centers for Disease Control and Prevention, 2019). Although the patterns related to the use of substances have been shifting over the last two decades, alcohol remains heavily misused with 11 million adults aged 26 or older meeting the criteria for alcohol use disorder; and slightly more than half of adults (51%) drank alcohol in the past month (Substance Abuse and Mental Health Services Administration [SAMHSA], 2020).

Geographic availability of alcohol can make it easier for individuals to purchase alcohol regularly. Availability theory suggests that the more alcohol that is available, the more will be consumed (Stockwell and Gruenewald, 2004). As alcohol consumption rises, more people will use alcohol excessively. Yet, we have seen that relationship of alcohol outlet density to drinking behaviors does not consistently show greater geographic availability related to more frequent or higher volume of alcohol consumed. Some evidence suggests that outlet density is related to alcohol use outcomes (Popova et al., 2009), but this relationship does not appear to be universal (Pollack et al., 2005; Milam et al., 2016). Higher densities of alcohol outlet were related to more frequent drinking in the past month among university students (Kypri et al., 2008), more frequent past year drinking and drinking to intoxication in youth (Chen et al., 2010), and more frequent lifetime use and past month heavy

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https://doi.org/10.1016/j.drugalcdep.2022.109352
Received 3 December 2021; Received in revised form 5 February 2022; Accepted 7 February 2022
Available online 11 February 2022

drinking (> 5 drinks in one setting) among adolescents aged 10–16 (Shih et al., 2015). In their longitudinal study with young adults, Foster et al. (2017) found that new openings of alcohol outlets were associated with higher daily alcohol intake. However, density of alcohol outlets was not related to heavy alcohol consumption as measured by more than seven alcohol drinks per week for females and more than 14 drinks for males aged 25–74 (Pollack et al., 2005), or to frequency of drinking in the past month among adolescents (Milam et al., 2016). Despite mixed results between outlet density with drinking behaviors, geographic availability of alcohol has been linked to a variety of problem behaviors, including child abuse and neglect (Freisthler, 2004; Freisthler et al., 2004, 2005; Freisthler and Gruenewald, 2013; Morton et al., 2014), violent assaults (Gruenewald et al., 2006; Branas et al., 2009), intimate partner violence (McKinney et al., 2009; Cunradi et al., 2011), and motor vehicle accidents (Cameron et al., 2012; Ponicki et al., 2013).

To date, most studies examining alcohol outlet density have done so using where people live (i.e., residential neighborhoods). Residential neighborhoods are often measured by U.S. Census tracts or Census block groups (U.S. Census Bureau, 2021) or in postal codes or output areas outside of the United States (Livingston, 2008; Maheswaran et al., 2018). When examining geographic availability of alcohol, different measures of availability may generate different results (Morrison et al., 2019; Freisthler et al., 2021). Morrison et al. (2019) found that different approaches to measuring exposure (residence-based vs. activity location-based vs. activity path-based) not only yielded different estimates of adolescents' contact to alcohol outlets, but also produced different associations between outlet exposure and alcohol use behaviors in youth. For example, a person who spends most of their time outside their residential neighborhood for work, shopping, and socializing, may be exposed to different risk for drinking, based on the outlet density in their activity space. Activity spaces, often measured as polygons, are defined as "the local areas within which people move or travel during the course of their activities during a specified time period" (Rai et al., 2007). Here, we would want to capture all the places where a person goes and create a measure that encapsulates the entire area where that movement occurred. Conversely, the most relevant geographic area may just be those destinations where a person spends time (e.g., work) and those immediate areas adjacent to that destination. This type of measure—called destination nodes—focuses on those endpoints for each destination, which might better show where people are actually bundling activities that might include shopping for alcohol (Freisthler et al., 2014b, 2021; Jones and Pebley, 2014).

Parents are a unique population of drinkers where the risk for harm to others can be higher as they are caring for minor children (Laslett et al., 2012; Kaplan et al., 2017; Tinnfält et al., 2018). Greater availability of alcohol through outlets in activity spaces could affect the frequency or volume of alcohol they drink (Stockwell and Gruenewald, 2004), thus conferring parenting risks, such as use of corporal punishment (Freisthler and Gruenewald, 2013) or not watching their children closely enough (Freisthler et al., 2015). Implicit learning through contextual cueing likely influences the role of alcohol availability in drinking behaviors (Chun and Jiang, 1998; Brockmole et al., 2006). Frequent and highly relevant contextual cues in a person's environment (e.g., seeing the same bar on the drive home from work) affect their cognitive processes in subliminal yet non-random ways, potentially influencing behaviors (e.g., deciding to stop at the bar after a stressful workday). This paper aims to answer the following research question: Does the relationship between alcohol outlet density and frequency of use or continued volume of alcohol differ when using geographic measures to denote availability among parents with children 10 years old or younger?

2. Material methods

2.1. Study design

We conducted a cross-sectional telephone and web-based survey of 1599 participants in 2015 across 30 cities in California, with an average of 53 participants (range 14–100) per city. These cities' populations were approximately 50,000 to 500,000 in 2010. Participants were parents or guardians with one child aged 10 years and under that lived with them at least 50% of the time, spoke English, and did not live in a congregate care setting. Listed telephone samples were used to identify phone numbers where city residents were likely to have children living in the home. The response rate for the listed sample was 42%. In an attempt to diversify our sample, we also advertised the study on Craigslist. Of the participants, 1435 were recruited via the listed sample, with the remaining 164 recruited through Craigslist. Upon contact, participants provided verbal consent and given the choice of completing the survey on the telephone ($n = 1315$) or via the internet ($n = 284$). An incentive of $35 was provided for the 30-minute survey. The study was approved by the institutional review boards at Pacific Institute for Research and Evaluation as original data collection and Ohio State University as exempt from human subjects review as all data were de-identified. Post-stratifications weights were constructed that adjusted for respondent's gender, race/ethnicity, and household type (e.g., female-headed household).

2.2. Sample

Our final sample consisted of 1599 study participants. The non-weighted sample was about two-thirds mothers and one-third fathers (see Table 1). The majority of our study participants were employed and had attended at least some college or a technical school after high school graduation. The majority of our study participants belonged to a non-white racial or ethnic group, with the primary group being Latinx.

2.3. Measures

Our primary dependent variables are frequency of drinking and continued volume of alcohol over 365 days. Frequency of drinking (F) is measured as the number of days a person drank in the past 365 days (also called number of drinking days). Participants were asked the number of days on which they had at least one alcoholic drink. Continued volume (CV) was measured by asking participants the number of days they had 2 or more, 3 or more, 6 or more, and 9 or more drinks. Finally, respondents were asked the most number of drinks they had in one sitting. These questions were used to create model-based estimates of the average volume of alcohol drank during each drinking event (Gruenewald et al., 2003a, 2003b). We then multiplied the frequency of drinking by the average number of drinks per drinking event to obtain the total volume (V) of alcohol consumed over 365 days. The frequency of drinking (which is also the number of times a participant had at least one drink) was subtracted (CV = V – F). This means the frequency of having one drink was not double-counted with the continued volume measure. As an example, a participant who drank 10 times in the past year, but only had 1 drink each time would have a frequency of 10 and a continued volume of 0 (10 days *1 drink −10 drinks = 0). A participant who drank on 10 days but had, on average, three alcoholic drinks would have a continued volume over the past year of 20 (10 days * 3 drinks – 10 drinks = 20). On average, study participants drank at least one drink on 40 days and consumed an additional 54 drinks during the past year.

Data on alcohol outlets were obtained from the Department of Alcoholic Beverage Control in California. Licenses were current as of January 2015. We combined licenses to create three categories: (1) bars and pubs (license types: 23, 40, 42, 48, 61, 75); (2) restaurants that serve alcohol (license types: 41, 47); and (3) off-premise alcohol outlets

Table 1
Descriptive statistics for dependent, primary independent and control variables.

	% or $\bar{x}$ (sd)	Sample n
Dependent Variables		
Drinking Frequency (# of days)	40.44 (74.59)	1590
Drinking Continued Volume (# of drinks)	54.15 (217.88)	1590
Primary Independent Variables		
Alcohol Outlet Density - Residential		
Bars per Area	0.50 (1.94)	1536
Restaurants per Area	3.65 (11.28	1536
Off-Premise per Area	3.36 (6.09)	1536
Alcohol Outlet Density - Polygons		
Bars per Area	0.80 (2.20)	1384
Restaurants per Area	7.21 (13.75)	1384
Off-Premise per Area	5.45 (7.89)	1384
Alcohol Outlet Density - Nodes		
Bars per Area	0.73 (1.37)	1523
Restaurants per Area	6.77 (9.12)	1523
Off-Premise per Area	4.65 (4.06)	1523
Control Variables		
Parent Age	40.50 (9.91)	1599
Biological Sex		
Female	49.2	1163
Male	50.8	436
Marital Status		
Married	74.0	1262
Single/Divorced/Widowed	26.0	329
Employment Status		
Full Time	56.5	784
Part-Time	12.8	227
Unemployed/ Other	30.7	578
Education		
< High School Diploma	6.6	119
High School Graduate	16.3	245
Some College or Technical School	32.0	493
College Graduate	29.2	473
Post-Baccalaureate Graduate	15.9	265
Race/Ethnicity		
White	41.3	707
Latinx	36.6	516
Black	5.9	154
Asian	24.3	114
Mixed or Other Race	3.7	58
# of Children ≤ 10 years	1.69 (0.83)	1599

(license types: 20, 21). Off-premise alcohol outlets are those where alcohol is purchased at the premise, but is consumed in another location (e.g., grocery store, convenience store).

Density of alcohol outlets was created for three different geographies: (1) residential neighborhoods; (2) convex hull polygons; and (3) destination nodes. Residential neighborhoods (operationalized here as Census block groups within which a participant's home address is located) is the most common way that the effects of alcohol outlet density on drinking or alcohol-related problems has been studied (Freisthler et al., 2021). We create activity spaces using convex hull polygons. Convex hull polygons are created by taking all the activity space points and creating a polygon that encompasses all the points in the smallest area possible. Again, this approach assumes that the majority of a participant's activities will occur within this area where many activities already occur. For a convex hull polygon, the participant had to identify at least three locations that could be geocoded. Destination nodes takes into account the most common places where a participant is likely to spend time. These places included their home, grocery stores (up to two) where they shopped, another store (drug store, big box store), child's school or pre-school, and parent's place of employment or school. A node is created by identifying the Census block group where the activity space point is located and calculating the number of alcohol outlets per area in those Census block groups. Thus, it takes into account density in the residential neighborhood as well as other block groups where the participant conducts other daily activities (e.g., grocery shopping). As mentioned, this approach recognizes that people tend to bundle errands, by conducting them in the same location as other activities. All alcohol outlet density variables were transformed using the natural log of the area measure to decrease the skewness of the distances before creating the density measure.

Control variables in the analysis include age of study participant ($M = 40.5$, $SD = 9.9$; Satre and Knight, 2001; Tan et al., 2015), biological sex (male = 1; Erol and Karpyak, 2015; Nolen-Hoeksema, 2004), marital status (married or living in a marriage-like relationship = 1, single, divorced, or widowed = 0; Dinescu et al., 2016; Liang and Chikritzhs, 2012), and number of children 10 years of age and younger. We also include variables related to socioeconomic status of the participants (Collins, 2016; Lasserre et al., 2022; Keyes and Hasin, 2008), including employment status (full-time, part-time, or unemployed/not in the workforce) and educational attainment (< high school diploma, high school graduate, some college or technical school, college graduate, post-baccalaureate graduate). Race and ethnicity were measured as White, Black or African American, Latinx, Asian or Asian American, Mixed or Other race (Tan et al., 2015; Shmulewitz and Hasin, 2019). For our model of the zero-inflation components, we included biological sex, age, marital status, number of children 10 years old or younger, and educational attainment.

2.4. Data analysis

We used zero inflated negative binomial models to analyze the effects of different geographic depictions of alcohol availability on drinking behaviors. These models provide a better fit than Poisson models for count data when the distribution is overdispersed (or the standard deviation is greater than the mean of the dependent variable). Zero-inflated models are used when some process may account for the preponderance of zeros. In our case, women may not drink on any days in the past year because they are pregnant and/or breastfeeding. However, they have consumed alcohol before the past year and will consume alcohol in the future. Similarly, a person who always acted as designated driver for the past year's drinking events may have had only one drink, meaning their continued volume would be 0. When they are not the designated driver, they consume more than one drink per drinking event. The first step in a zero-inflated model is to conduct a logit model to assess the likelihood that an individual is a certain zero. As with other logits, predictors of certain zero are included in the model. The zero-inflated negative binomial is then assessed using independent and control variables. We assess three models for each outcome variable, assessing alcohol outlet density by (1) residential nodes, (2) convex hull polygons, and (3) destination nodes. Standard errors are adjusted due to clustering within the 30 cities.

We conducted bivariate analyses to assess if respondents with missing data differed from those without missing data on all variables. The primary source of missing data was the density of alcohol outlets in convex hull polygons as about 13% of study participants did not have three activity location points that could be geocoded. The remaining variables used in this analysis had fewer than 5% missing values. Using independent samples t-test, we found no significant effect ($t(1590) = -0.230$, $p = .818$) in drinking frequency for those cases missing data ($M = 41.40$, $SD = 76.1$) compared to those not missing data ($M = 40.25$, $SD = 74.3$). Similarly, respondents with missing data ($M = 49.30$, $SD = 163.5$) were not statistically different ($t(1590) = 0.400$, $p = .689$) from those that did not have missing data ($M = 55.13$, $SD = 227.4$). For our demographic control variables, we only had two variables that differed for those with missing data compared to those that did not. We found statistically significant differences $X^2(4, N = 1557) = 10.369$, $p = 0.035$) by race/ethnicity of those with and without missing data. Caregiver age also differed statistically ($t(1590) = -2.700$, $p = .007$) where those with missing data were approximately 2 years older ($M = 41.98$, $SD = 9.76$) than those who did not have missing data ($M = 40.20$, $SD = 9.92$). Finally, only one of our primary independent variables had differences that were statistically significant ($t(1523) = 2.163$, $p = 0.031$), where cases that did not have missing data had higher density of bars using destination nodes ($M = 1.90$, $SD = 10.55$) than those that did not have missing data ($M = 0.15$, $SD = 10.73$).

3. Results

Table 2 shows the results for frequency of drinking. Across all three geographies, older parents drank more frequently, as did male caregivers. Compared to being unemployed or not in the workforce, parents employed in a part-time capacity reported drinking alcohol more frequently. Latinx and Asian and Asian American parents drank less frequently than their White counterparts. Marital status and number of children were not related to how frequently parents drank alcohol in the past year. Density of bars ($b = 0.0139$, 95% CI = 0.0016, 0.0261) in residential neighborhoods were related to drinking more frequently. No other outlet density measure was related to drinking frequency in these models. Our zero-inflated components also show that older parents and parents with more children were more likely to have a predicted certain 0. In other words, being older and having more children means that a person is a true abstainer when they report being an abstainer. Having higher levels of education (compared to participants who did not graduate high school) was related to less certainty of a true zero for drinking frequency. Vuong tests were conducted to test whether the zero-inflated negative binomial model was a better fit than just the negative binomial model. In all three models with frequency of drinking as the outcome, the Vuong test was statistically significant at $p < 0.001$, suggesting the zero-inflated models provided a better fit.

Similar to our findings related to drinking frequency, demographic measures related to the continued volume of drinking were fairly consistent across the three geographies (see Table 3). Parents who were older and fathers (compared to mothers) drank a higher continued volume of alcohol. Asian and Asian American parents drank less continued volume compared to White respondents. Latinx parents drank lower continued volumes in the models using convex hull polygons to assess alcohol outlet density. High levels of education (compared to less than a high school diploma), except for college graduates, were related to higher continued volumes of drinking. Similar to frequency of drinking, the density of bars per logged area ($b = 0.0295$, 95% CI = 0.0067, 0.0522) were positively related to continued volume in residential neighborhoods. Density of bars ($b = 0.0070$, 95% CI = 0.0019, 0.0121) and restaurants ($b = 0.0018$, 95% CI = 0.0003, 0.0033) in destination nodes were related to having a higher continued volume of alcohol. Off-premise outlet density ($b = -0.0026$, 95% CI = −0.0049, −0.0002) was negatively related to continued volume in destination nodes. Variables that predicted zero-inflation included age, male biological sex, and educational attainment. Males and higher education levels were less likely to have a certain 0 for drinking continued volume and older parents were more likely to have a certain 0. For all three models, the Vuong test showed the zero-inflated models provided a

Table 2
Relationship of geographic availability of alcohol outlets and frequency of drinking by parents.

	Residential Neighborhoods[a] (n = 1465)		Convex Hull Polygons[a] (n = 1327)		Destination Nodes[a] (n = 1458)	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Constant	2.4786	(1.6988, 3.2584)[b]	2.3960	(1.4910, 3.3009)[c]	2.4456	(1.5949, 3.2964)[b]
Parent Age	0.0183	(0.0029, 0.0337)[c]	0.0248	(0.0091, 0.0405)[d]	0.0183	(0.0027, 0.0338)[c]
Biological Sex (ref: Female)						
Male	0.6333	(0.3589, 0.9077)[b]	0.6292	(0.3720, 0.8864)[b]	0.6389	(0.3715, 0.9063)[b]
Marital Status (ref: Single)						
Married	0.1328	(−0.1615, 0.4270)	0.1470	(−0.1476, 0.4416)	0.1362	(−0.1446, 0.4170)
Employment Status (ref: Unemployed)						
Full Time	0.0023	(−0.2682, 0.2728)	0.0346	(−0.2528, 0.3219)	0.0611	(−0.2035, 0.3256)
Part-Time	0.5203	(0.0354, 1.00520)[c]	0.6525	(0.1710, 1.1341)[d]	0.5567	(0.0914, 1.0220)[c]
Education (ref: < High School Graduate)						
High School Graduate	0.4459	(−0.1917, 1.0835)	0.4200	(−0.1359, 0.9759)	0.4529	(−0.1593, 1.0650)
Some College or Technical School	0.4551	(−0.0974, 1.0076)	0.4645	(−0.0797, 1.0087)	0.4719	(−0.1007, 1.0446)
College Graduate	0.7054	(0.1858, 1.2249)[d]	0.4972	(−0.0069, 1.0014)	0.6862	(0.1636, 1.2089)[c]
Post Baccalaureate Graduate	0.6226	(0.0758, 1.1695)[c]	0.5921	(0.0452, 1.1390)[c]	0.6577	(0.0932, 1.2223)[c]
Race/Ethnicity (ref: White)						
Latinx	-0.6572	(−0.9422, −0.3721)[b]	-0.7192	(−1.0073, −0.4310)[b]	-0.6029	(−0.8887, −0.3172)[b]
Black or African American	-0.0764	(−0.3993, 0.2466)	-0.2788	(−0.6337, 0.0762)	-0.1095	(−0.4273, 0.2083)
Asian or Asian American	-1.2574	(−1.7157, −0.7990)[b]	-1.1519	(−1.6425, −0.6614)[b]	-1.2244	(−1.6953, −0.7534)[b]
Mixed or Other Race	-0.0054	(−0.6179, 0.6071)	0.0486	(−0.6810, 0.7782)	-0.0264	(−0.6437, 0.5910)
# of Children	-0.0744	(−0.2092, 0.0604)	-0.1562	(−0.3216, 0.0091)	-0.0733	(−0.2106, 0.0640)
Alcohol Outlet Density						
Bars per Area	0.0139	(0.0016, 0.0261)[c]	0.0055	(−0.0046, 0.0157)	0.0059	(−0.0027, 0.0145)
Restaurants per Area	-0.0026	(−0.0070, 0.0018)	0.0010	(−0.0011, 0.0031)	-0.0005	(−0.0011, 0.0002)
Off-Premise per Area	0.0002	(−0.0030, 0.0033)	-0.0013	(−0.0053, 0.0028)	0.0005	(−0.0002, 0.0012)
Zero-Inflation						
Constant	-2.6001	(−4.3944, −0.8057)[d]	-2.8576	(−5.2789, −0.4363)[c]	-2.5034	(−4.5090, −0.4978)[c]
Parent Age	0.0416	(0.0104, 0.0727)[c]	0.0478	(0.0089, 0.0867)[c]	0.0412	(0.0077, 0.0748)[c]
Biological Sex						
Male	-0.3025	(−0.8961, 0.2911)	-0.2853	(−0.9767, 0.4060)	-0.2201	(−0.8337, 0.3935)
Marital Status						
Married	0.0794	(−0.4868, 0.6456)	0.0730	(−0.5916, 0.7376)	0.0548	(−0.5327, 0.6424)
# of Children	0.4018	(0.0037, 0.7999)[c]	0.4301	(−0.0139, 0.8742)	0.4011	(0.0532, 0.7491)[c]
Education (ref: < High School Graduate)						
High School Graduate	-0.7777	(−1.5890, 0.0335)	-0.8373	(−1.6603, −0.0143)[c]	-0.7194	(−1.4858, 0.0469)
Some College or Technical School	-1.4008	(−2.1965, −0.6050)[d]	-1.4906	(−2.3847, −0.5965)[d]	-1.4458	(−2.1769, −0.7147)[b]
College Graduate	-1.8365	(−2.7676, −0.9054)[b]	-1.9884	(−3.1343, −0.8426)[d]	-1.8475	(−2.6925, −1.0024)[b]
Post Baccalaureate Graduate	-1.1860	(−1.8992, −0.4728)[d]	-1.1669	(−1.9597, −0.3742)[d]	-1.2149	(−1.9285, −0.5012)[d]
Akaike Information Criterion	7.928		7.919		7.904	

[a] Standard errors adjusted for 30 city clusters.
[b] $p < 0.001$
[c] $p < 0.05$,
[d] $p < 0.01$.

Table 3
Relationship of Geographic Availability of Alcohol Outlets and Continued Volume of Alcohol Consumed by Parents.

	Residential Neighborhoods[a] (n = 1465)		Convex Hull Polygons[a] (n = 1327)		Destination Nodes[a] (n = 1458)	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Constant	2.8064	(1.7946, 3.8182)	2.5534	(1.4343, 3.6725)[b]	2.5798	(1.6203, 3.5393[b]
Parent Age	0.0272	(0.0027, 0.0518)[c]	0.0390	(0.0155, 0.0625)[d]	0.0301	(0.0055, 0.0547)[c]
Biological Sex (ref: Female)						
Male	0.8449	(0.4440, 1.2458)[b]	0.8545	(0.4785, 1.2305)[b]	0.9313	(0.5294, 1.3331)[b]
Marital Status (ref: Single)						
Married	-0.3993	(−0.8181, 0.0195)	-0.3563	(−0.7173, 0.0048)	-0.3830	(−0.7354, −0.0306)[c]
Employment Status (ref: Unemployed)						
Full Time	-0.2731	(−0.6683, 0.1220)	-0.2274	(−0.6237, 0.1689)	-0.1581	(−0.5105, 0.1944)
Part-Time	-0.0457	(−0.7314, 0.6399)	0.1534	(−0.5095, 0.8162)	-0.0193	(−0.6581, 0.6195)
Education (ref: < High School Graduate)						
High School Graduate	1.1637	(0.3374, 1.9900)[d]	1.0969	(0.4397, 1.7542)[d]	1.0667	(0.3641, 1.7692)[d]
Some College or Technical School	0.8684	(0.2285, 1.5083)[d]	0.9543	(0.2985, 1.6101)[d]	0.9181	(0.2619, 1.5744)[d]
College Graduate	0.6402	(−0.0030, 1.2833)	0.3996	(−0.2645, 1.0638)	0.6347	(−0.0560, 1.3255)
Post Baccalaureate Graduate	0.6883	(0.1365, 1.2401)[c]	0.7542	(0.1590, 1.3494)[c]	0.7737	(0.1428, 1.4047)[c]
Race/Ethnicity (ref: White)						
Latinx	-0.4260	(−0.8796, 0.0276)	-0.5425	(−1.0493, −0.0358)[c]	-0.3766	(−0.8702, 0.1170)
Black and African American	-0.4259	(−1.3098, 0.4580)	-0.7074	(−1.7506, 0.3357)	-0.3243	(−1.2523, 0.6038)
Asian and Asian American	-1.0315	(−1.7184, −0.3446)[d]	-0.7149	(−1.4109, −0.0189)[c]	-0.9098	(−1.5824, −0.2372)[d]
Mixed or Other Race	-0.5181	(−1.1313, 0.0950)	-0.3490	(−1.2071, 0.5090)	-0.4349	(−1.1061, 0.2363)
# of Children	-0.0992	(−0.3267, 0.1282)	-0.2365	(−0.4548, −0.0182)[c]	-0.1196	(−0.3364, 0.0972)
Alcohol Outlet Density						
Bars per Area	0.0295	(0.0067, 0.0522)[c]	0.0052	(−0.0070, 0.0173)	0.0070	(0.0019, 0.0121)[d]
Restaurants per Area	-0.0048	(−0.0123, 0.0026)	-0.0001	(−0.0025, 0.0024)	0.0018	(0.0003, 0.0033)[c]
Off-Premise per Area	0.0012	(−0.0031, 0.0055)	-0.0001	(−0.0033, 0.0031)	-0.0026	(−0.0049, −0.0002)[c]
Zero-Inflation						
Constant	-0.6327	(−1.8939, 0.6284)	-0.8261	(−2.1692, 0.5171)	-0.6652	(−2.0733, 0.7430)
Parent Age	0.0278	(0.0044, 0.0511)[c]	0.0330	(0.0111, 0.0549)[d]	0.0318	(0.0083, 0.0553)[d]
Biological Sex						
Male	-0.7445	(−1.1464, −0.3425)[b]	-0.7286	(−1.1108, −0.3465)[b]	-0.6894	(−1.0763, −0.3024)[b]
Marital Status						
Married	0.3113	(−0.1724, 0.7951)	0.3068	(−0.2774, 0.8910)	0.2492	(−0.2622, 0.7606)
# of Children	0.1202	(−0.1192, 0.3597)	0.1260	(−0.1249, 0.3769)	0.1161	(−0.1135, 0.3457)
Education (ref: < High School Graduate)						
High School Graduate	-0.6267	(−1.3869, 0.1335)	-0.5572	(−1.3923, 0.2780)	-0.6276	(−1.4441, 0.1888)
Some College or Technical School	-1.1330	(−1.7792, −0.4867)[d]	-1.1567	(−1.8327, −0.4806)[d]	-1.2158	(−1.8724, −0.5592)[b]
College Graduate	-1.1707	(−1.9643, −0.3771)[d]	-1.1138	(−2.0114, −0.2161)[c]	-1.2506	(−2.0939, −0.4073)[d]
Post Baccalaureate Graduate	-0.8689	(−1.6077, −0.1301)[c]	-0.7968	(−1.6339, 0.0404)	-0.9263	(−1.7375, −0.1151)[c]
Akaike Information Criterion	6.385		6.355		6.377	

[a] Standard errors adjusted for 30 city clusters.
[b] $p < 0.001$
[c] $p < 0.05$,
[d] $p < 0.01$.

better fit than the negative binomial without inflation.

4. Discussion

The predominant geographic area for understanding the role of alcohol outlet density on alcohol use and related problems has focused on residential neighborhoods (Freisthler et al., 2021, 2014b). Our study sought to expand this literature by focusing on density of alcohol outlets by other geographies that better represent where parents spend their time and may better reflect those contexts where they purchase and consume alcohol. For residential neighborhoods (operationalized using Census tracts), density of bars per area was positively related to number of drinking days in the past year and the continued volume of alcohol consumed during the same time frame. Neither density of restaurants or off-premise alcohol outlets in residential neighborhoods were related to frequency of drinking or continued volume. No outlet densities were related to drinking frequency or continued volume when using convex hull polygons. On the other hand, using destination nodes (measured as the Census block groups where common activities occurred), greater density of bars and restaurants were related to higher continued volumes of drinking in the past year. Density of off-premise alcohol outlets were negatively related to higher continued volume for parents of young children. None of the outlet density measures in destination nodes were related to frequency of drinking.

Parents living in residential neighborhoods with higher bar densities drank on more days and drank more alcohol (as measured by continued alcohol) during the past year, similar to Morrison et al. (2019) which found that density of bars in most residence-based measures were related to any alcohol use among adolescents. Adults who drink in bars are known to drink higher mean volumes (Nyaronga et al., 2009). Bars may represent an opportunity for adult-only social interactions that are attractive to parents who have high levels of social companionship support (Freisthler et al., 2014a). When living in a neighborhood with higher density of bars, passing those bars could have a cueing effect such that parents who had a bad day or want to celebrate an event, may decide to use alcohol. Finally, parents who drink frequently and in higher quantities may choose to live in areas that appear to be friendly to drinkers, as evidenced by the number and location of local bars and pubs.

Density of restaurants that serve alcohol in destinations nodes lend credence to the idea that people bundle errands and may revisit the same places for multiple activities. These areas are zoned for commercial and mixed use that host a range of activities that might be useful for parents with young children. They may also host chain restaurants (e.g., Applebee's, Outback Steakhouse) that serve alcohol and are appropriate for bringing children (as opposed to bars or pubs). Greater densities of these restaurants may provide more choices for parents and opportunities to drink. Destination nodes with higher density of off-premise outlets were negatively related to drinking frequency. Mair et al. (2020) also found a negative relationship between high off-premise outlet density and frequency of drinking in microenvironment settings (nearby traffic intersections). Our work extends this finding to destination nodes. However, this work differs from previous work finding no relationship of outlet density and any alcohol use with activity space measures (Morrison et al., 2019). The relationship to off-premise outlet density to drinking behaviors remains opaque and needs additional study to understand these relationships.

Examining outlet density using convex hull polygons were not related to either frequency of drinking or continued volume of alcohol consumed. This presentation of activity spaces creates a polygon of activity locations that form the smallest area yet contains all the locations. Although convex hull polygons include all the activity locations, similar to destination nodes, by seeking to minimize the area of the polygon, this geography might be capturing primarily places where parents are driving from point to point, but not spending additional time. Freisthler et al. (2021) found that the majority of drinking events by parents occurred in routine locations. However, alcohol use was more frequent in rare locations that parents went within convex hull polygons (as opposed to outside the polygon; Freisthler et al., 2021). Unknown is whether these polygons have higher or lower density of different types of alcohol outlets. The fact that the location was depicted as rare may indicate that these parents drank less frequently than other parents.

Consistent with other work, men drank more frequently and consumed higher continued volumes (Russell et al., 2004). White parents drank on more days than Latinx or Asian parents and at higher volumes than Asian parents. Whites consistently drink more than Asians, but the findings related to Latinx drinking behaviors have been more nuanced as Latinx populations lower levels of alcohol use disorders but higher rates of binge drinking (Vaeth et al., 2017). Higher densities of alcohol outlets, particularly off-premise alcohol outlets, are often found in residential neighborhoods with higher percentages of Black and Brown individuals (LaVeist and Wallace, 2000; Scott et al., 2020). However, Whites, who drink more and more frequently, may do so at venues where alcohol is more expensive (e.g., bars and restaurants that serve alcohol). Thus, outlet density and drinking behaviors may be a reflection of people who have more disposable income not captured in socioeconomic status measures included here. A better understanding how overconcentration of off-premise outlets and the mechanisms by which they affect alcohol-related problems, particularly in racial and ethnic minority neighborhoods, is needed.

Our study uses three different methods to assess how geographic context, as it relates to the availability of alcohol through outlets, is associated with drinking frequency and continued volume in a sample of parents in California. This is a cross-sectional study, which inhibits our ability to assess causality. Past year drinking measures might be subject to recall bias among our participants. We only assessed a handful of ways that activity spaces can be operationalized. Further, we did not collect any information on activity patterns (i.e., the travel patterns and time spent in various locations using global positioning devices). These patterns will provide more information about how parents travel throughout the areas where they live and how much time they spend in various locations, including restaurants and bars. With this, we can better assess how and where outlet density may promote or restrict drinking for parents. We are limited in our assessment of polygons to examine this relationship as we needed three activity locations that could be geocoded. The missing data—due to lack of three geocoded points—might have decreased statistical power, resulting in no outlet densities being related to alcohol use behaviors. As a way to ensure a third geocodable point, parents can be asked another place they spend a lot of time and include family or friend's homes as options. Convex hull polygons may also be limited because, without travel patterns, the activity spaces are likely to include places the parents don't go. Further our study might not be generalizable to all populations of parents.

5. Conclusion

Outlet densities in residential neighborhood and destination node appear to be related to number of drinking days and continued volume of alcohol. Future work should seek to determine why and how these geographies are related to alcohol use behaviors and if they differ for parents compared to other adults. Examining this relationship could also be a stepping stone to understanding how outlet density and alcohol use affect alcohol-related problems among parents. As this work advances, a natural extension might identify how individual and environmental characteristics moderate the relationship between outlet density in destination nodes and alcohol use. Through this line of inquiry, potential policy levers might be identified that could reduce alcohol use and related problems.

Role of Funding Source

This project was supported by grant number P60-AA-006282 from the National Institute on Alcohol Abuse and Alcoholism. The content is solely the responsibility of the authors and does not necessarily represent the National Institute on Alcohol Abuse and Alcoholism or the National Institutes of Health.

CRediT authorship contribution statement

Bridget Freisthler designed the study and wrote the first draft of the manuscript. Uwe Wernekinck conducted and wrote the literature review. Both authors contributed to the interpretation of the data and the final version of the paper. Both authors approved the final manuscript.

Conflict of Interest

No conflict declared.

References

Branas, C.C., Elliott, M.R., Richmond, T.S., Culhane, D.P., Wiebe, D.J., 2009. Alcohol consumption, alcohol outlets, and the risk of being assaulted with a gun. Alcohol. Clin. Exp. Res 335, 906–915.

Brockmole, J.R., Castelhano, M.S., Henderson, J.M., 2006. Contextual cueing in naturalistic scenes: Global and local contexts. J. Exp. Psychol. Learn. Mem. Cogn. 32, 699.

Cameron, M.P., Cochrane, W., McNeill, K., Melbourne, P., Morrison, S.L., Robertson, N., 2012. Alcohol outlet density is related to police events and motor vehicle accidents in Manukau City, New Zealand. Aust. N. Z. Public Health 36, 537–542.

Centers for Disease Control and Prevention, 2019, Key statistics from the national survey of family growth – B listing. Retrieved from: https://www.cdc.gov/nchs/nsfg/key_statistics/b_2015–2017.htm#agefb.

Chen, M.J., Grube, J.W., Gruenewald, P.J., 2010. Community alcohol outlet density and underage drinking. Addict 105, 270–278.

Chun, M.M., Jiang, Y., 1998. Contextual cueing: Implicit learning and memory of visual context guides spatial attention. Cogn. Psychol. 36, 28–71.

Collins, S.E., 2016. Associations between socioeconomic factors and alcohol outcomes. Alcohol Res-Curr. Rev. 38 (1), 83.

Cunradi, C.B., Mair, C., Ponicki, W., Remer, L., 2011. Alcohol outlets, neighborhood characteristics, and intimate partner violence: ecological analysis of a California city. J. Urban Health 88, 191–200.

Dinescu, D., Turkheimer, E., Beam, C.R., Horn, E.E., Duncan, G., Emery, R.E., 2016. Is marriage a buzzkill? A twin study of marital status and alcohol consumption. J. Fam. Psych. 30 (6), 698.

Erol, A., Karpyak, V.M., 2015. Sex and gender-related differences in alcohol use and its consequences: Contemporary knowledge and future research considerations. Drug Alcohol Depen 156, 1–13.

Foster, S., Trapp, G., Hooper, P., Oddy, W.H., Wood, L., Knuiman, M., 2017. Liquor landscapes: does access to alcohol outlets influence alcohol consumption in young adults? Health Place 45, 17–23.

Freisthler, B., 2004. A spatial analysis of social disorganization, alcohol access, and rates of child maltreatment in neighborhoods. Child. Youth Serv. Rev. 26, 803–819.

Freisthler, B., Holmes, M.R., Wolf, J.P., 2014a. The dark side of social support: Understanding the role of social support, drinking behaviors and alcohol outlets for child physical abuse. Child Abus. Negl. 38, 1106–1119.

Freisthler, B., Gruenewald, P.J., 2013. Where the individual meets the ecological: A study of parent drinking patterns, alcohol outlets, and child physical abuse. Alcohol. Clin. Exp. Res. 37, 993–1000.

Freisthler, B., Kepple, N.J., Wolf, J.P., Carson, L., 2021. Activity spaces: Assessing differences in alcohol exposures and alcohol use for parents. GeoJournal 86, 69–79.
Freisthler, B., Lipperman-Kreda, S., Bersamin, M., Gruenewald, P.J., 2014b. Tracking the when, where, and with whom of alcohol use: Integrating ecological momentary assessment and geospatial data to examine risk for alcohol-related problems. Alcohol Res 36, 29.
Freisthler, B., Midanik, L.T., Gruenewald, P.J., 2004. Alcohol outlets and child physical abuse and neglect: Applying routine activities theory to the study of child maltreatment. J. Stud. Alcohol. 65, 586–592.
Freisthler, B., Needell, B., Gruenewald, P.J., 2005. Is the physical availability of alcohol and illicit drugs related to neighborhood rates of child maltreatment? Child Abus. Negl. 29, 1049–1060.
Freisthler, B., Price Wolf, J., Johnson-Motoyama, M., 2015. Understanding the role of context-specific drinking in neglectful parenting behaviors. Alcohol Alcohol 50, 542–550. https://doi.org/10.1093/alcalc/agv031.
Gruenewald, P.J., Freisthler, B., Remer, L., LaScala, E.A., Treno, A., 2006. Ecological models of alcohol outlets and violent assaults: crime potentials and geospatial analysis. Addict 101, 666–677.
Gruenewald, P.J., Johnson, F., Light, J., Lipton, R., Saltz, R., 2003a. Understanding college drinking: Assessing dose-response from survey self-reports. J. Stud. Alcohol. 64, 500–514.
Gruenewald, P.J., Johnson, F., Light, J., Saltz, R., 2003b. Drinking to extremes: Theoretical & empirical analyses of peak drinking levels drinking among college students. J. Stud. Alcohol. 64, 817–824.
Jones, M., Pebley, A.R., 2014. Redefining neighborhoods using common destinations: Social characteristics of activity spaces and home census tracts compared. Demogr 51, 727–752.
Kaplan, L.M., Nayak, M.B., Greenfield, T.K., Karriker-Jaffe, K.J., 2017. Alcohol's harm to children: Findings from the 2015 United States National Alcohol's Harm to Others Survey. J. Pediatr. 184, 186–192.
Keyes, K.M., Hasin, D.S., 2008. Socio-economic status and problem alcohol use: the positive relationship between income and the DSM-IV alcohol abuse diagnosis. Addiction 103 (7), 1120–1130.
Kypri, K., Langley, J.D., Saunders, J.B., Cashell-Smith, M.L., Herbison, P., 2008. Randomized controlled trial of web-based alcohol screening and brief intervention in primary care. Arch. Intern. Med. 168, 530–536.
Laslett, A.M., Ferris, J., Dietze, P., Room, R., 2012. Social demography of alcohol-related harm to children in Australia. Addict 107, 1082–1089.
Lasserre, A.M., Imtiaz, S., Roerecke, M., Heilig, M., Probst, C., Rehm, J., 2022. Socioeconomic status, alcohol use disorders, and depression: a population-based study. J. Affect. Disord. https://doi.org/10.1016/j.jad.2021.12.132.
LaVeist, T.A., Wallace Jr, J.M., 2000. Health risk and inequitable distribution of liquor stores in African American neighborhood. Soc. Sci. Med. 51 (4), 613–617.
Liang, W., Chikritzhs, T., 2012. Brief report: marital status and alcohol consumption behaviours. J. Subst., Use 17 (1), 84–90.
Livingston, M., 2008. Alcohol outlet density and assault: A spatial analysis. Addict 103, 619–628.
Maheswaran, R., Green, M.A., Strong, M., Brindley, P., Angus, C., Holmes, J., 2018. Alcohol outlet density and alcohol related hospital admissions in England: A national small-area level ecological study. Addict 113, 2051–2059.
Mair, C., Sumetsky, N., Gruenewald, P.J., Lee, J.P., 2020. Microecological relationships between area income, off-premise alcohol outlet density, drinking patterns, and alcohol use disorders: The east bay neighborhoods study. Alcohol. Clin. Exp. Res. 44, 1636–1645.
McKinney, C.M., Caetano, R., Harris, T.R., Ebama, M.S., 2009. Alcohol availability and intimate partner violence among US couples. Alcohol. Clin. Exp. Res 33, 169–176.
Milam, A.J., Johnson, S.L., Furr-Holden, C.D.M., Bradshaw, C.P., 2016. Alcohol outlets and substance use among high schoolers. J. Community Psychol. 44, 819–832.
Morrison, C.N., Byrnes, H.F., Miller, B.A., Kaner, E., Wiehe, S.E., Ponicki, W.R., Wiebe, D. J., 2019. Assessing individuals' exposure to environmental conditions using residence-based measures, activity location–based measures, and activity path–based measures. Epidemiol 30, 166–176.
Morton, C.M., Simmel, C., Peterson, N.A., 2014. Neighborhood alcohol outlet density and rates of child abuse and neglect: moderating effects of access to substance abuse services. Child Abus. Negl. 38, 952–961.
Nolen-Hoeksema, S., 2004. Gender differences in risk factors and consequences for alcohol use and problems. Clin. Psychol. Rev. 24 (8), 981–1010.
Nyaronga, D., Greenfield, T.K., McDaniel, P.A., 2009. Drinking context and drinking problems among Black, White, and Hispanic men and women in the 1984, 1995, and 2005 US National Alcohol Surveys. J. Stud. Alcohol Drugs 70, 16–26.
Ponicki, W.R., Gruenewald, P.J., Remer, L.G., 2013. Spatial panel analyses of alcohol outlets and motor vehicle crashes in California: 1999–2008. Accid. Anal. Prev. 55, 135–143.
Pollack, C.E., Cubbin, C., Ahn, D., Winkleby, M., 2005. Neighbourhood deprivation and alcohol consumption: Does the availability of alcohol play a role? Int. J. Epidemiol. 34, 772–780.
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 Alcohol 44, 500–516.
Rai, R.K., Balmer, M., Rieser, M., Vaze, V.S., Schönfelder, S., Axhausen, K.W., 2007. Capturing human activity spaces: New geometries. Transp. Res. Rec. 2021, 70–80.
Russell, M., Light, J.M., Gruenewald, P.J., 2004. Alcohol consumption and problems: The relevance of drinking patterns. Alcohol. Clin. Exp. Res 28, 921–930.
Satre, D.D., Knight, B.G., 2001. Alcohol expectancies and their relationship to alcohol use: age and sex differences. Aging Ment. Health 5 (1), 73–83.
Scott, J., Danos, D., Collins, R., Simonsen, N., Leonardi, C., Scribner, R., Herd, D., 2020. Structural racism in the built environment: Segregation and the overconcentration of alcohol outlets. Health Place 64, 102385.
Shih, R.A., Mullins, L., Ewing, B.A., Miyashiro, L., Tucker, J.S., Pedersen, E.R., D'Amico, E.J., 2015. Associations between neighborhood alcohol availability and young adolescent alcohol use. Psychol. Addict. Behav. 29, 950.
Shmulewitz, D., Hasin, D.S., 2019. Risk factors for alcohol use among pregnant women, ages 15–44, in the United States, 2002 to 2017. Prev. Med. 124, 75–83.
Substance Abuse and Mental Health Services Administration, 2020, Key substance use and mental health indicators in the United States: Results from the 2019 National Survey on Drug Use and Health (HHS Publication No. PEP20–07-01–001, NSDUH Series H-55). Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration. Retrieved from ⟨https://www.samhsa.gov/data/⟩.
Stockwell, T., Gruenewald, P.J., 2004. Controls on the physical availability of alcohol. In: Heather, N., Stockwell, T. (Eds.), The Essential Handbook of Treatment and Prevention of Alcohol Problems. Wiley, pp. 213–234.
Tan, C.H., Denny, C.H., Cheal, N.E., Sniezek, J.E., Kanny, D., 2015. Alcohol use and binge drinking among women of childbearing age—United States, 2011–2013. MMWR-Morb. Morta. W. 64 (37), 1042–1046.
Tinnfält, A., Fröding, K., Larsson, M., Dalal, K., 2018. "I Feel It In My Heart When My Parents Fight": Experiences of 7–9-Year-Old Children of Alcoholics. Child Adolesc. Soc. Work J. 35, 531–540.
United States Census Bureau, 2021, Glossary. Retrieved from: ⟨https://www.census.gov/programs-surveys/geography/about/glossary.html⟩.
Vaeth, P.A., Wang-Schweig, M., Caetano, R., 2017. Drinking, alcohol use disorder, and treatment access and utilization among US racial/ethnic groups. Alcohol. Clin. Exp. Res. 41, 6–19.