

## Alcohol Advertising and Violence

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**Introduction:** Numerous studies have found associations between alcohol outlet density and violence, but it is unknown whether alcohol advertisements visible outside outlets are also associated with violent crime. Baltimore City, MD enacted restrictions on retail alcohol establishment advertising practices as of June 5, 2017. This study examines the association between alcohol advertisements visible outside off-premise alcohol outlets and violent crime before this restriction.

**Methods:** Outlet observations ( $n=683$ ) were conducted in summer 2015, and violent crime data ( $n=24,085$ ) were from June 5, 2015, through June 4, 2017. The number of violent crimes per square mile within 1,000 feet of outlets was summed using kernel density estimation. In 2018–2019, authors used mixed models with a Simes–Benjamini–Hochberg correction for multiple testing.

**Results:** Roughly half (47%,  $n=267$ ) of the outlets with complete data ( $n=572$ ) had alcohol advertisements visible from the exterior. Outlets with alcohol advertisements had 15% more violent crimes per square mile within 1,000 feet ( $e^{\beta}=1.15$ , 95% CI=1.07, 1.25,  $q<0.001$ ) after adjusting for neighborhood context. All associations between alcohol advertisements and specific types of violent crime were significant, with the association strongest for homicides ( $e^{\beta}=1.28$ , 95% CI=1.13, 1.46,  $q<0.001$ ). There was no association between cigarette advertisements and violent crime ( $e^{\beta}=1.08$ , 95% CI=0.92, 1.26,  $q=0.43$ ).

**Conclusions:** Alcohol advertisements visible outside off-premise outlets were associated with increased violent crime over and above the association between the outlets themselves and violent crime. Reducing alcohol advertising visible from the street may decrease risk of violent crime that is associated with alcohol outlets.

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### INTRODUCTION

In the U.S., approximately 21 homicides a day are considered attributable to excessive alcohol use.<sup>1</sup> Each additional liter of absolute alcohol consumed per capita is associated with an 8% increase in the homicide rate in the U.S.<sup>2</sup> and a 9% increase in Australia.<sup>3</sup> At the individual level, there is a dose–response relationship between alcohol consumption and aggression.<sup>4</sup> The density of stores selling alcohol (i.e., alcohol outlets) is also closely linked with level of violence,<sup>5</sup> but it is unlikely that all alcohol outlets contribute to this violence equally.<sup>6</sup> Identifying modifiable characteristics of problem outlets could help tailor prevention strategies.

Alcohol advertising may be a feature of outlets that contributes to violent crime.<sup>6–8</sup> Off-premise alcohol outlets (e.g., packaged goods stores where patrons buy

alcohol to consume off-site), where approximately 76% of alcohol in the U.S. is sold,<sup>9</sup> are a common site for alcohol advertising. Though 2 systematic reviews have found relationships between alcohol advertising exposure

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and youth drinking,<sup>10,11</sup> there are 3 reasons why alcohol advertisements may increase violence: (1) Advertisement exposure increases alcohol consumption,<sup>10,11</sup> which could then increase violent crime<sup>12</sup>; (2) advertisements often display price discounts, and low-price alcohol is independently associated with higher levels of consumption<sup>13</sup> and violence<sup>14</sup>; and (3) advertisement content shapes social norms in ways that promote aggression and violence.<sup>8</sup> Exposure to violence and alcohol advertising are not the same for all communities, with risks significantly higher in black communities.<sup>5,15–20</sup>

To date, the authors are aware of only 3 manuscripts describing an association between advertising on alcohol outlets and violent crime, only 2 of which empirically test that association.<sup>8</sup> A 2018 analysis of survey data from South Africa found that women reporting high exposure to alcohol advertisements in their communities were 4.2 times more likely also to report being victims of intimate partner violence.<sup>7</sup> A study of 3 California communities found that advertisements with Latina models were associated with higher rates of sexual violence against Latina and non-Latina women.<sup>8</sup> These studies demonstrate that an association between alcohol advertising and violence may exist. However, the South African study relied on self-reported advertisement and violence data, which are subject to under-reporting. Both studies were in unique contexts that may not generalize to most of the U.S. Finally, the South African study did not adjust for alcohol outlet density, so their measure of alcohol advertisements may be a proxy for the outlets themselves. The California study adjusted for outlets but did so using unadjusted counts of outlets, which the authors' prior work has demonstrated to be prone to error.<sup>21</sup>

Baltimore passed a comprehensive zoning code update called TransForm Baltimore on December 5, 2016, with an estimated 2-year implementation period.<sup>22</sup> Under the new regulations, it is illegal to post signs, posters, graphics or other items that advertise alcoholic beverages in a publicly visible location, with one exception for licensed premises, which may display an external sign if the purpose is to identify the business, using the business' name, slogan, or logo; the size is no greater than 15% of the exterior wall or window space; and the outlet has no other window or exterior signs on the same street frontage.<sup>23</sup>

The primary research question is whether there is an empirical relationship between presence of alcohol advertisements visible outside off-premise alcohol outlets and density of violent crime around the outlet. The unit of analysis is the outlet itself, which is nested within Census tracts (CTs). Mixed models are used to separate outlet-specific associations from

contextual effects and adjust for off-premise outlet clustering.

## METHODS

### Study Sample

Data were obtained from the Board of Liquor License Commissioners for Baltimore City for establishments permitted to sell alcohol for off-site consumption in 2015 ( $n=683$ ). Teams of research assistants conducted alcohol outlet observations in 2015. The observation instrument collected data about advertisements visible from outside the outlet. Complete exterior advertising data were available for 572 (83.7%) alcohol outlets.

To understand whether these alcohol advertisements were still present after TransForm Baltimore went into effect (June 5, 2017), the authors compared 2015 and 2018 observation data (more than a full year after TransForm Baltimore went into effect) for a subset of outlets ( $n=45$ ) and found little change. The agreement rate was 86% (Cohen's  $\kappa=0.73$ ). Five outlets rated differently in 2015 and 2018: 4 had advertisements in 2018 but not 2015, and 1 had advertisements in 2015 but not 2018.

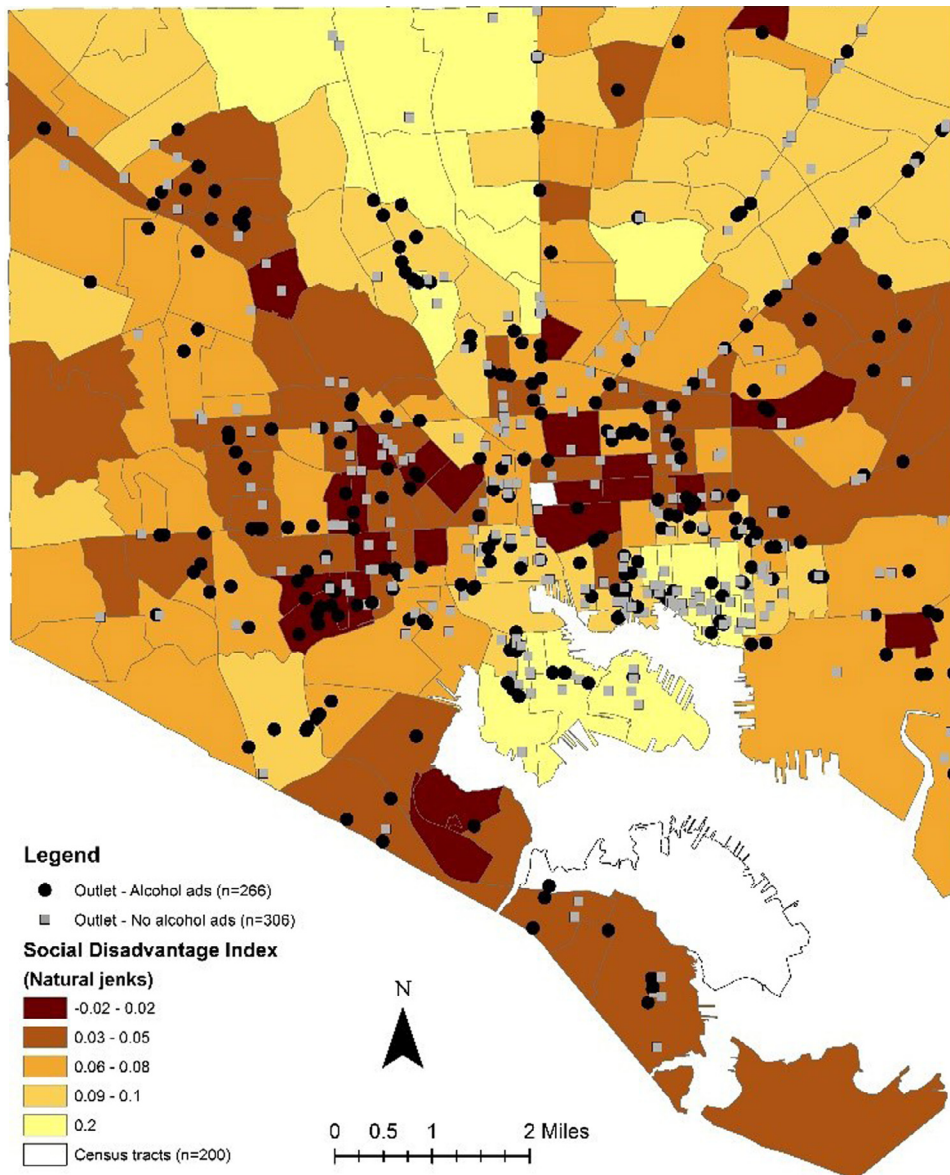
Victim-based violent crime incident data were obtained from the Baltimore City Police Department. Violent crime was defined using the Federal Bureau of Investigation Uniform Crime Reporting definition: homicide, forcible rape, aggravated assault (including nonfatal shootings), and robbery.<sup>24</sup> Authors measured violent crime after the outlet observations (summer 2015) and before TransForm Baltimore went into effect. Thus, the violent crime data spanned June 1, 2015 through June 4, 2017. The level and distribution of violent crime were compared for 2015–2016 and 2016–2017 by type of crime. There were slightly more crimes in 2016–2017 but the distribution was the same.

### Measures

Kernel density estimation was used to measure the expected count of violent crimes within 1,000 feet of each off-premise outlet, given that a quarter mile (1,320 feet) is considered walking distance in urban areas.<sup>25</sup> The violent crime variable summed the kernel density estimation raster values that fell within 1,000 feet of each outlet. The authors then calculated crime density per square mile by dividing these counts by the area of the buffer (0.11 square miles). They transformed all violent crime variables using the natural logarithm to adjust for positive skew.

Authors obtained demographic covariates from the 2017 American Community Survey 5-year estimates at the CT level because the margins of error are lower at the CT level than at the Census block group level. They included percentage black, median annual household income, and percentage of the population who were male and aged 15–24 years because blacks, low-income individuals, and male youth tend to have the highest levels of violence exposure.<sup>26</sup> The median annual household income variable was scaled so that a 1-unit increase corresponded to \$10,000.

The authors used a social disadvantage index calculated by subtracting the sum of 2 percentages for positive outcomes (i.e., adults aged  $\geq 25$  years with a college degree and owner-occupied housing) from 2 negative outcomes (i.e., households with incomes below the federal poverty line and female-headed households).<sup>27</sup> A 1-unit increase in this scale corresponded to a 10% increase in each of the 4 components. Figure 1 shows the distribution of



**Figure 1.** Distribution of alcohol outlets permitted to sell alcohol for off-premise consumption by presence of alcohol advertisements on the building exterior and Social Disadvantage Index, Baltimore City 2015–2017.

alcohol outlets with alcohol advertisements visible outside and the social disadvantage index, where darker areas indicate higher disadvantage.

Four covariates describing the built environment were included: (1) off-premise alcohol outlet clusters, (2) drug arrest density, (3) vacant housing density, and (4) land use zoning. The authors calculated off-premise alcohol outlet density using the Getis–Ord  $G_i^*$ ,<sup>28</sup> which is a local measure of spatial dependence that identifies hot spots where the density of points is greater than the study area. Variables for drug arrest and vacant property density at the CT level were calculated and transformed using the same methods as used to measure violent crime. Finally, land use zoning shapefiles were obtained from the Baltimore City Department of Planning and a

spatial join was performed to determine the zoning type in which each outlet was located.

### Statistical Analysis

The primary research question was: Do off-premise alcohol outlets with alcohol advertisements visible outside have higher violent crime density within 1,000 feet? Secondly, the authors asked whether this association was from the advertisements themselves or the context in which the advertisements are located. Random effects modeling was used to account for the lack of independence between alcohol outlets nested within the same CT. Random effects models can separate outlet-level and cluster (CT)-level

associations. In these models, the CT proportion tested whether outlets with alcohol advertisements located in a CT with a higher proportion of outlets with alcohol advertisements had a stronger association with violent crime. This serves as a proxy for neighborhood effects such as social milieu.

Stata (version 14.2, release 14, StataCorp, College Station, TX, 2015) was used to fit the mixed models in 2018–2019. The random effects models used random intercepts and fixed effects for the independent variables (ad exposure) and covariates. The models assumed that alcohol outlets within a CT had an identity structure.

The authors first ran a series of unadjusted random effects models with no covariates. They then ran 4 sets of models that each had 5 dependent variables: total crime, homicide, aggravated assault, forcible rape, and robbery. The first set of models examined alcohol advertising and the second examined cigarette advertising. The second set of models with cigarette advertisements tested whether it was the advertisement content or the characteristics of outlets that display advertisements that drove any associations with violent crime. All regressions report a *q*-value estimated using the Simes–Benjamini–Hochberg correction for multiple testing,<sup>29</sup> with *q*-values  $\leq 0.05$  considered statistically significant. Authors repeated our statistical models using generalized estimating equations specifying a Gaussian family, identity link, and exchangeable correlation structure and obtained nearly identical results (data not shown).

The authors used R, version 3.5.2 for spatial analyses.<sup>30</sup> Spatial dependence in the violent crime outcomes and regression residuals was assessed using Moran's Index (Moran's *I*). There was positive spatial dependence in the outcomes (Moran's *I*=0.41,  $p < 0.001$ ). The regression covariates explained all the spatial dependence for models of homicide and aggravated assault and most of the spatial dependence for total violent crime, rape, and robbery (Moran's  $I \leq 0.03$ ,  $p < 0.05$ ). A Huber–White sandwich estimator of the variance was used to obtain robust SEs to account for the residual spatial dependence. Even if the robust SEs did not account for all of this residual spatial dependence, the inferences should be approximately accurate because the residual dependence was small and most of the associations were highly significant.

## RESULTS

The final sample included 572 alcohol outlets selling alcohol for off-site consumption (Table 1). Nearly half

(46.5%) had alcohol advertising visible from outside the building. The average CT in which these outlets with alcohol advertisements were located had a population density of 3,131 residents and (similar to Baltimore overall)<sup>31</sup> was mostly composed of black residents (61.7%).

The intraclass correlation coefficient was 0.79, suggesting that random effects models were appropriate for the nested data structure. Outlets with alcohol advertisements visible outside had higher levels of aggravated assault ( $e^B=1.17$ , 95% CI=1.07, 1.28,  $p < 0.001$ ), homicide ( $e^B=1.31$ , 95% CI=1.26, 1.52,  $p < 0.001$ ), and robbery density ( $e^B=1.18$ , 95% CI=1.05, 1.31,  $p < 0.01$ ) within 1,000 feet compared with alcohol outlets without visible advertisements.

The presence of alcohol advertisements was associated with higher levels of violent crime density immediately around the outlet after adjusting for outlet characteristics, off-premise alcohol outlet clustering, and neighborhood characteristics ( $e^B=1.15$ , 95% CI=1.07, 1.25,  $q < 0.001$ ; Table 2). The association between alcohol advertising and violent crime was strongest for homicide; the presence of alcohol advertisements visible outside an off-premise outlet was associated with 28.4% more homicides within 1,000 feet than outlets without these advertisements ( $e^B=1.28$ , 95% CI=1.13, 1.46,  $q < 0.001$ ). Alcohol outlets with alcohol advertisements were also associated with 16.2% more aggravated assaults ( $e^B=1.16$ , 95% CI=1.07, 1.26,  $q < 0.001$ ) and forcible rapes ( $e^B=1.16$ , 95% CI=1.04, 1.28,  $q=0.01$ ) and 15.0% more robberies ( $e^B=1.15$ , 95% CI=1.06, 1.25,  $q < 0.001$ ).

The association between alcohol advertising and violence held after adjusting for the CT-level proportion of outlets with alcohol advertisements. Increases in the CT-level proportion of outlets with alcohol advertisements visible outside were associated with lower levels of violent crime density ( $e^B=0.75$ , 95% CI=0.58, 0.97,  $q=0.04$ ).

**Table 1.** Summary of Alcohol Outlets and Census Tracts Included in Analysis, Baltimore City 2015–2017

Characteristics	Percent or mean	SD	Minimum	Maximum
Outlets (n=572)				
Any alcohol advertisements visible from outlet exterior, % (n)	46.6 (267)			
Any tobacco advertisements visible from outlet exterior, % (n)	7.2 (41)			
Census tracts (n=153)				
Population, n	3,131	1,405	697	7,144
Population who are black, %	61.7	34.6	0.5	100.0
Population who are Hispanic/Latino, %	5.4	7.6	0.0	43.1
Population who are white, %	28.8	29.1	0.0	91.8
Median annual household income	\$49,537	\$27,134	\$14,452	\$145,966
Drug arrest density per square mile, mean	44	41	1	211
Vacant housing density per square mile, mean	147	130	8	684

**Table 2.** Regression Results for Level of Crime Around the Outlet and Any Alcohol Advertisements Visible Outside in Baltimore City, 2015–2017

Variable	Violent crime		Homicide		Aggravated assault		Forcible rape		Robbery	
	exp(B) <sup>a</sup> (95% CI)	q-value <sup>b</sup>	exp(B) (95% CI)	q-value	exp(B) (95% CI)	q-value	exp(B) (95% CI)	q-value	exp(B) (95% CI)	q-value
Alcohol advertisements										
No	ref		ref		ref		ref		ref	
Yes	<b>1.15 (1.07, 1.25)</b>	<b>&lt;0.001</b>	<b>1.28 (1.13, 1.46)</b>	<b>&lt;0.001</b>	<b>1.16 (1.07, 1.26)</b>	<b>&lt;0.001</b>	<b>1.16 (1.04, 1.28)</b>	<b>0.012</b>	<b>1.15 (1.06, 1.25)</b>	<b>0.001</b>
Mean prevalence of advertisements	<b>0.75 (0.58, 0.97)</b>	<b>0.043</b>	<b>0.50 (0.27, 0.90)</b>	<b>0.045</b>	0.79 (0.54, 1.17)	0.318	0.77 (0.54, 1.09)	0.218	<b>0.70 (0.53, 0.93)</b>	<b>0.021</b>
Off-premise outlet cluster										
No	ref		ref		ref		ref		ref	
Yes	<b>1.73 (1.42, 2.10)</b>	<b>&lt;0.001</b>	1.67 (1.03, 2.69)	0.069	<b>2.27 (1.67, 3.06)</b>	<b>&lt;0.001</b>	<b>1.65 (1.27, 2.16)</b>	<b>0.001</b>	<b>1.75 (1.42, 2.16)</b>	<b>&lt;0.001</b>
% black	1.16 (0.79, 1.72)	0.524	<b>9.03 (3.60, 22.42)</b>	<b>&lt;0.001</b>	1.79 (0.98, 3.22)	0.078	1.28 (0.76, 2.16)	0.390	0.84 (0.55, 1.26)	0.415
Median annual income <sup>c</sup>	0.99 (0.92, 1.05)	0.646	1.08 (0.92, 1.27)	0.436	<b>0.84 (0.76, 0.93)</b>	<b>0.001</b>	1.03 (0.94, 1.12)	0.511	1.00 (0.93, 1.07)	0.992
% male, aged 15–24 years	1.22 (0.97, 1.52)	0.112	1.27 (0.74, 2.18)	0.436	1.11 (0.78, 1.55)	0.592	1.35 (1.00, 1.84)	0.089	<b>1.32 (1.03, 1.68)</b>	<b>0.033</b>
Social disadvantage index <sup>d</sup>	<b>1.30 (1.09, 1.52)</b>	<b>0.003</b>	<b>1.88 (1.25, 2.80)</b>	0.007	1.08 (0.84, 1.39)	0.587	<b>1.46 (1.16, 1.82)</b>	<b>0.003</b>	<b>1.23 (1.03, 1.48)</b>	<b>0.027</b>
Drug arrest density	<b>1.35 (1.21, 1.49)</b>	<b>&lt;0.001</b>	<b>1.88 (1.46, 2.44)</b>	<b>&lt;0.001</b>	<b>1.35 (1.14, 1.60)</b>	<b>0.001</b>	<b>1.49 (1.28, 1.72)</b>	<b>&lt;0.001</b>	<b>1.32 (1.17, 1.48)</b>	<b>&lt;0.001</b>
Vacant housing density	<b>0.84 (0.75, 0.93)</b>	<b>0.003</b>	<b>0.72 (0.55, 0.94)</b>	<b>0.042</b>	<b>0.81 (0.68, 0.96)</b>	<b>0.022</b>	<b>0.79 (0.68, 0.91)</b>	<b>0.005</b>	<b>0.78 (0.69, 0.89)</b>	<b>&lt;0.001</b>
Zoning										
Commercial	ref		ref		ref		ref		ref	
Industrial	<b>0.53 (0.43, 0.64)</b>	<b>&lt;0.001</b>	0.83 (0.57, 1.19)	0.436	<b>0.53 (0.43, 0.66)</b>	<b>&lt;0.001</b>	0.84 (0.63, 1.12)	0.296	<b>0.70 (0.57, 0.88)</b>	<b>0.003</b>
Residential	0.97 (0.90, 1.05)	0.524	1.00 (0.86, 1.16)	0.977	0.95 (0.87, 1.04)	0.346	1.04 (0.92, 1.17)	0.511	0.93 (0.85, 1.02)	0.174
Other	<b>0.66 (0.51, 0.86)</b>	<b>0.003</b>	0.80 (0.49, 1.30)	0.436	<b>0.68 (0.52, 0.91)</b>	<b>0.015</b>	1.25 (0.87, 1.79)	0.298	<b>0.67 (0.51, 0.89)</b>	<b>0.009</b>
Moran's index	<b>0.02 (-0.29)</b>	<b>0.04</b>	-0.02	0.99	<0.01	0.56	<b>0.03</b>	<b>0.001</b>	<b>0.03</b>	<b>&lt;0.001</b>

Note: Boldface indicates that the corrected q-value<0.05.

<sup>a</sup>Exponentiated regression coefficients presented because the regression outcome (violent crime density) was transformed using the natural logarithm.

<sup>b</sup>Adjusted probability score using a Simes–Benjamini–Hochberg false discovery rate correction.

<sup>c</sup>Median annual household income, censored at \$250,000 and scaled so a unit increase equals \$10,000.

<sup>d</sup>Calculated as (((% female-headed households/10) + (% families living in poverty/10)) - [(% owner-occupied housing/10) + (% adults aged 25+ with college degree/10)])/4.

This suggests a saturation model where the first outlet(s) with alcohol advertisements in a CT has (have) a stronger association with violent crime than additional outlets with advertisements in CTs where more than half of the outlets already display advertisements.

The authors tested interaction terms between the alcohol outlet advertisement indicator and off-premise alcohol outlet clustering indicator for each type of violent crime. None were significant, suggesting that the association between alcohol advertising and violent crime does not differ within and outside of clusters of off-premise outlets. However, the association between off-premise alcohol outlet density clusters and violent crime was significant for all types of violent crime, and strongest for aggravated assaults; outlets with alcohol advertisements visible outside and located inside a cluster of off-premise outlets had 127.0% more aggravated assaults per square mile ( $e^B=2.27$ , 95% CI=1.35, 3.82,  $q<0.001$ ).

Authors explored associations between cigarette advertising and violent crime to test whether the associations for alcohol advertising could derive from characteristics of outlets that display advertisements in general (Table 3). Overall, there was no association ( $e^B=1.08$ , 95% CI=0.92, 1.26,  $q=0.43$ ). Models that stratified by type of violent crime also found no association.

## DISCUSSION

This study sought to explore associations between 2 contextual risk factors—outlet-level alcohol advertising and alcohol outlet clustering—and violence and found that both were independently and positively associated with violent crime. Publicly visible alcohol advertisements were associated with approximately 15% higher levels of aggravated assault, forcible rape, and robbery and nearly 30% higher levels of homicide. Thus, off-premise outlets with alcohol advertisements visible from outside tended to have approximately 3 more homicides, aggravated assaults, and robberies near them per year on average than outlets without such advertisements. Also, alcohol outlets located inside an off-premise outlet cluster had roughly 70% higher density of total violent crime, forcible rapes, and robberies and 125% higher density of aggravated assaults compared with off-premise outlets in low-density areas.

Publicly visible alcohol advertisements may normalize alcohol consumption, make outlets look more appealing, and make alcohol appear more affordable, thus attracting more customers and a different mix of customers. Alcohol advertisements could be an indicator of place management strategies, directly determining who patronizes the outlet and indirectly determining the level of violent

crime based on how patrons interact.<sup>6</sup> Outlets charging higher prices for alcoholic drinks tend to draw an older, less violence-prone crowd, which may be why price discounting is associated with violence<sup>6</sup>; however, the role of the alcohol advertisements may also be more nuanced. For example, market segmentation divides potential customers into categories and tailors advertisement content to them. When marginalized groups see alcohol advertisements that contain others from that group, it leverages the way viewers connect with the actors/actresses to amplify advertisement content.<sup>32</sup> Previous findings that alcohol advertisements that sexualize Latinas were associated with violence against women support this interpretation. Unfortunately, these data did not permit the authors to determine which of these possible mechanisms may contribute to the associations we report here. Future research should explore these pathways as well as reasons why some outlet owners post alcohol advertisements.

Although it is possible that the association between the alcohol advertising and violent crime is the result of an unmeasured confounder, this study explored several alternate hypotheses. First, it investigated whether the association resulted from the advertisement context by using the off-premise outlet cluster indicator and CT-level proportion of outlets with advertisements. All the associations between alcohol advertising and violent crime were significant after adjusting for these contextual variables. The study also tested the neighborhood hypothesis, which argues that associations between outlets and harms result from the surrounding context.<sup>6</sup> Associations may be spurious if the CTs that had alcohol outlets with advertisements were different from the CTs where outlets had no advertisements (data not shown). The authors compared 3 types of CTs: (1) CTs with outlets with advertisements, (2) CTs with no alcohol outlets with advertisements, and (3) CTs with both some outlets with advertisements and some without. The only significant difference was between Types 2 and 3, but this no longer held after adjusting for underlying population. Finally, the study used outlets with cigarette advertisements to test whether the association could result from an unmeasured characteristic of outlets that display advertisements. The models did not detect any associations between outlets and violent crime, which suggests the association was specific to alcohol advertisements.

Future research should test potential mechanisms and longitudinal associations to better understand these cross-sectional associations. TransForm Baltimore, a new set of comprehensive zoning regulations, permits alcohol outlets to display 1 sign taking up <15% of exterior window space, and that sign must identify the name of the outlet.<sup>23</sup> Enforcement of this new code presents the opportunity for a natural experiment.

**Table 3.** Regression Results for Level of Violent Crime Around Off-Premise Outlets and Cigarette Advertisements, Baltimore City 2015–2017

Variable	Violent crime		Homicide		Aggravated assault		Forcible rape		Robbery	
	exp(B) <sup>a</sup> (95% CI)	q-value <sup>b</sup>	exp(B) (95% CI)	q-value	exp(B) (95% CI)	q-value	exp(B) (95% CI)	q-value	exp(B) (95% CI)	q-value
Cigarette advertisements										
No	ref		ref		ref		ref		ref	
Yes	1.08 (0.92, 1.26)	0.426	1.05 (0.81, 1.38)	0.815	1.06 (0.90, 1.25)	0.551	1.07 (0.87, 1.32)	0.558	1.11 (0.94, 1.31)	0.258
Mean prevalence of advertisements	0.84 (0.56, 1.25)	0.462	0.92 (0.38, 2.23)	0.908	0.95 (0.54, 1.67)	0.856	0.84 (0.49, 1.43)	0.558	0.74 (0.48, 1.14)	0.212
Off-premise outlet cluster										
No	ref		ref		ref		ref		ref	
Yes	<b>1.72 (1.40, 2.10)</b>	<b>&lt;0.001</b>	1.67 (1.03, 2.69)	0.098	<b>2.27 (1.67, 3.06)</b>	<b>&lt;0.001</b>	<b>1.65 (1.26, 2.16)</b>	<b>0.001</b>	<b>1.73 (1.40, 2.16)</b>	<b>&lt;0.001</b>
% black	1.17 (0.79, 1.73)	0.462	<b>9.21 (3.63, 23.10)</b>	<b>&lt;0.001</b>	1.79 (0.99, 3.25)	0.083	1.30 (0.77, 2.18)	0.442	0.84 (0.55, 1.28)	0.456
Median annual income <sup>c</sup>	0.99 (0.93, 1.05)	0.789	1.11 (0.94, 1.30)	0.419	<b>0.85 (0.77, 0.93)</b>	<b>0.001</b>	1.03 (0.95, 1.13)	0.547	1.01 (0.94, 1.07)	0.819
% male, aged 15–24 years	1.23 (0.98, 1.54)	0.117	1.32 (0.77, 2.27)	0.421	1.11 (0.79, 1.57)	0.599	1.36 (1.00, 1.84)	0.094	<b>1.34 (1.04, 1.70)</b>	<b>0.035</b>
Social disadvantage index <sup>d</sup>	<b>1.30 (1.11, 1.54)</b>	<b>0.004</b>	<b>1.90 (1.26, 2.83)</b>	<b>0.008</b>	1.08 (0.84, 1.39)	0.599	<b>1.46 (1.17, 1.82)</b>	<b>0.002</b>	<b>1.25 (1.04, 1.49)</b>	<b>0.026</b>
Drug arrest density	<b>1.35 (1.21, 1.49)</b>	<b>&lt;0.001</b>	<b>1.88 (1.45, 2.44)</b>	<b>&lt;0.001</b>	<b>1.35 (1.14, 1.60)</b>	<b>0.001</b>	<b>1.49 (1.28, 1.72)</b>	<b>&lt;0.001</b>	<b>1.31 (1.17, 1.48)</b>	<b>&lt;0.001</b>
Vacant housing density	<b>0.84 (0.74, 0.93)</b>	<b>0.003</b>	0.73 (0.55, 0.95)	0.066	<b>0.81 (0.68, 0.96)</b>	<b>0.028</b>	<b>0.79 (0.68, 0.91)</b>	<b>0.005</b>	<b>0.78 (0.69, 0.88)</b>	<b>&lt;0.001</b>
Zoning										
Commercial	ref		ref		ref		ref		ref	
Industrial	<b>0.52 (0.43, 0.64)</b>	<b>&lt;0.001</b>	0.81 (0.56, 1.17)	0.421	<b>0.53 (0.42, 0.65)</b>	<b>&lt;0.001</b>	0.83 (0.63, 1.11)	0.332	<b>0.70 (0.56, 0.88)</b>	<b>0.004</b>
Residential	0.96 (0.89, 1.05)	0.462	0.99 (0.85, 1.16)	0.908	0.94 (0.86, 1.04)	0.323	1.03 (0.92, 1.16)	0.578	0.93 (0.85, 1.02)	0.159
Other	<b>0.66 (0.51, 0.86)</b>	<b>0.004</b>	0.81 (0.50, 1.32)	0.502	<b>0.68 (0.51, 0.90)</b>	<b>0.016</b>	1.23 (0.86, 1.79)	0.381	<b>0.67 (0.51, 0.89)</b>	<b>0.010</b>
Moran's index	<b>0.02</b>	<b>0.03</b>	<0.01	0.93	<0.01	0.50	<b>0.03</b>	<b>&lt;0.001</b>	<b>0.03</b>	<b>&lt;0.001</b>

Note: Boldface indicates that the corrected q-value<0.05.

<sup>a</sup>Exponentiated regression coefficients presented because the regression outcome (violent crime density) was transformed using the natural logarithm.

<sup>b</sup>Adjusted probability score using a Simes–Benjamini–Hochberg false discovery rate correction.

<sup>c</sup>Median annual household income, censored at \$250,000 and scaled so a unit increase equals \$10,000.

<sup>d</sup>Calculated as (((% female-headed households/10) + (% families living in poverty/10)) – [(% owner-occupied housing/10) + (% adults aged 25+ with college degree/10)])/4.

## Limitations

The observational data only included off-premise outlets. Though these have a stronger association with violent crime than on-premise outlets,<sup>8,20</sup> the effects of alcohol advertisements visible from outside the outlets should be independent of the effects of the outlets themselves. Not having data about advertisement exposure outside on-premise outlets ( $n=519$ ) reduced the statistical power and may limit the generalizability of the findings. In addition, the measure of alcohol advertisements was crude. Future research should consider more-refined measures such as the number or dimensions of alcohol advertisements. Some regressions contained positive residual spatial dependence, meaning that the SEs may be slightly narrower, increasing the chance for a Type I error. However, this study used robust SEs, and the associations were large, so this should not change the inference. Finally, the authors were unable to adjust for other neighborhood-level factors like collective efficacy and alcohol law enforcement/monitoring, which may affect outlet operations and levels of violent crime.

## CONCLUSIONS

This study suggests that reducing alcohol advertising visible from the street may be an effective means of reducing risk in neighborhoods. There is substantial evidence of the impact of alcohol advertising on youth,<sup>10,11</sup> but little research on its effects on adults. Future research is needed into this relationship as well as its potential impact in specific neighborhood contexts. Given the large and consistent association between off-premise alcohol outlets and violence and the epidemics of violence being experienced by cities such as Baltimore that also have large numbers of alcohol outlets relative to populations, this arena is ripe for both research and policy innovation. The authors encourage active enforcement of the limit on alcohol advertising visible from outside alcohol outlets in Baltimore, which would make possible a more rigorous pre–post analysis that would be better designed to determine whether the associations found here are causal in nature.

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DHJ and RHE conceptualized the analysis. PJT and NG conducted exploratory data analyses, and PJT developed and conducted the final analyses with input from DHJ, RHE, and NG. With RHE help with the literature review, PJT wrote the first draft of the manuscript, and all study authors critically reviewed and revised the manuscript. DF-H and AJM designed and oversaw the outlet observations to collect the advertising data.

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