The Impact of Single-Container Malt Liquor Sales Restrictions on Urban Crime

Patricia McKee · Darin J. Erickson · Traci Toomey ·
Toben Nelson · Elyse Levine Less · Spruha Joshi ·
Rhonda Jones-Webb

Published online: 7 March 2017
© The New York Academy of Medicine 2017

Abstract Many US cities have adopted legal restrictions on high-alcohol malt liquor sales in response to reports of crime and nuisance behaviors around retail alcohol outlets. We assessed whether these policies are effective in reducing crime in urban areas. We used a rigorous interrupted time-series design with comparison groups to examine monthly crime rates in areas surrounding alcohol outlets in the 3 years before and after adoption of malt liquor sales restrictions in two US cities. Crime rates in matched comparison areas not subject to restrictions served as covariates. Novel methods for matching target and comparison areas using virtual neighborhood audits conducted in Google Street View are described. In Minneapolis, Minnesota, sales of single containers of 16 oz or less were prohibited in individual liquor stores ($n = 6$). In Washington, D.C., the sale of single containers of any size were prohibited in all retail alcohol outlets within full or partial wards ($n = 6$). Policy adoption was associated with modest reductions in crime, particularly assaults and vandalism, in both cities. All significant outcomes were in the hypothesized direction. Our results provide evidence that retail malt liquor sales restrictions, even relatively weak ones, can have modest effects on a range of crimes. Policy success may depend on community

support and concurrent restrictions on malt liquor substitutes.

Keywords Alcohol · Local policy · Malt liquor · Chronic public inebriation

Introduction

Malt liquor is a troublesome product for urban communities. Several studies have shown that consumption of high-alcohol malt liquor contributes to crime around retail outlets where it is sold [1–7]. These crimes include nuisance behaviors such as public inebriation, disorderly conduct, trespassing, littering, loitering and panhandling, as well as more serious offenses such as property damage and assaults. In 2008, a majority of alcohol-control officials surveyed in 115 large US cities said malt liquor consumption was a serious problem in their communities [1]. Nearly a third of these cities have enacted legal restrictions on malt liquor sales [1,7]. This paper examines the impact of those policies on a range of crimes in two cities.

Malt liquor is defined here as inexpensive, high-alcohol beer (6–9% alcohol by volume) often sold in large (16 to 40 oz) single containers. Several factors may contribute to the association of malt liquor consumption with crime. A 40-oz bottle of malt liquor, typically consumed as a single serving before it gets warm or flat, can contain as much alcohol as a six-pack of regular beer. Consuming one 40-oz bottle, therefore, meets the definition of heavy episodic or binge drinking (five

P. McKee (✉) · D. J. Erickson · T. Toomey · T. Nelson ·
E. L. Less · S. Joshi · R. Jones-Webb
Division of Epidemiology & Community Health, School of Public
Health, University of Minnesota, 1300 South 2nd St, Suite 300,
Minneapolis, MN 55454, USA
e-mail: mckee038@umn.edu

drinks in 2 h for men)—a risky form of excessive consumption [8]. Drinking at this level is associated with violence and disorderly conduct [9,10].

The sale of single-serve alcohol beverage containers has been linked with violent crime around retail outlets [11] and alcohol-related vehicle crashes [12]. Single containers of malt liquor are typically sold chilled and wrapped in paper bags, facilitating immediate public consumption near retail outlets. Retail outlets are stores that sell alcohol for consumption off the premises, such as liquor stores, grocery and convenience stores, gas stations, and general merchandise stores. A substantial body of research links retail alcohol outlets with crime and public nuisance activities [13–17]. Outlets lacking responsible management (such as those that promote cheap, high-alcohol beverages, sell singles, sell to underage patrons, or allow loitering on their grounds) may provide permissive settings for excessive consumption and opportunities for inebriated offenders and victims to come together [17–19].

Typical patterns of malt liquor use substantiate the potential for problems around retail outlets. These include drinking outdoors and during the daytime, [20, 21] rapid consumption, [22] and heavy drinking [20, 23]. Finally, malt liquor is widely available and heavily promoted on storefronts in many urban, low-income, and minority neighborhoods already disproportionately affected by high crime rates [24].

Legal Restrictions on Malt Liquor Sales

Communities can respond to alcohol-related problems by working with businesses and individuals to promote responsible sales and consumption, or by enacting state and local alcohol-control policies [25–27]. A common form of local control is regulation of the density, location and/or practices of retail alcohol outlets, often through city zoning ordinances. (Zoning ordinances control land use, stipulating the types of businesses that may operate in certain areas of the city, and under what conditions.) Communities also regulate retail alcohol outlet practices by placing conditions of operation on individual licenses on a case-by-case basis, for example, when a retailer repeatedly violates alcohol-control regulations, or when neighbors complain about crime and nuisance issues around a particular establishment.

Conditions of operation may be used alone or in combination to achieve goals such as increasing store security (e.g., requiring video cameras and exterior

lighting); reducing neighborhood disorder (e.g., prohibiting loitering, limiting storefront alcohol ads, and requiring litter and graffiti removal); or limiting alcohol availability (e.g., reducing store hours and restricting the sale of certain products popular with youth or chronic public inebriates, such as wine coolers, flavored malt beverages, small bottles of spirits, fortified wine, and high-alcohol malt liquor) [28]. To restrict the availability of high-alcohol malt liquor, many communities prohibit the sale of large containers, single containers, or split or “broken” packages, while others prohibit the sale of chilled bottles, specific brands, or malt beverages over a specified percent alcohol. Exceptions are often made for expensive craft beers and imports [7].

Evaluation of local alcohol policies can inform future community efforts to protect residents from consumption-related problems. Some policies, such as limits on outlet density and hours of sale, have been associated with reductions in alcohol availability and consumption-related problems [13, 29, 30]. However, few evaluations of malt liquor restrictions exist in the peer-reviewed literature [31, 32]. In one report prepared for the Washington State Liquor Board, Tamai found that police calls for alcohol-related incidents declined after 34 brands of high-alcohol, low price beer, and wine products were banned in two Alcohol Impact Areas in the city of Seattle [3]. In a Minneapolis pilot study, Barajas et al. found an association between outlet-level single-container sales restrictions and decreases in disorderly conduct [33].

The current study evaluates the effectiveness of single-container restrictions in two cities, at two levels of implementation: the outlet level in Minneapolis, Minnesota, and the ward level in Washington, D.C. We hypothesized that restrictions would be associated with decreases in alcohol-related crimes in targeted neighborhoods. Based on previous reports, we particularly expected decreases in less-serious crimes, such as disorderly conduct and vandalism [1, 3, 6, 23, 33].

Methods

We used an interrupted time-series design with comparison group (ITS-CG) to examine the relationship between malt liquor sales restrictions (“policies”) and crime rates in Minneapolis, Minnesota and Washington, D.C., populations 382,578 and 601,712,

respectively [34]. An ITS-CG design uses several waves of observation in both intervention and comparison groups before and after the introduction of an intervention [35]. We compared monthly crime rates in targets areas (subject to malt liquor policies) for 3 years before and after policy adoption.

Establishing whether crime reductions are due to a single policy can be challenging in non-randomized, quasi-experiments. For example, reductions in crime around an alcohol outlet may be due to changes in other alcohol policies that were implemented at the same time malt liquor restrictions were adopted (e.g., restrictions on the number of new alcohol outlet licenses in high crime areas). Interrupted time series is commonly used in these types of studies, but the major problem is that alternative explanations for the change can be difficult to rule out (history threat to validity). We used an ITS-CG design to address this issue. The ITS-CG adds a nonequivalent control group to the interrupted time series. Assuming an appropriate comparison group (matched geographically and on other important covariates), this design can control for secular and seasonal patterns as well as threats to internal validity, such as history. Including comparison neighborhoods from the same city strengthens the study design and allows us to control for changes in other local alcohol policies and covariates that could also affect crime outcomes [15].

The creation of study areas is described below. All study methods were reviewed and approved by the University of Minnesota Institutional Review Board.

Data Collection and Measures

Our independent variable of interest was the presence or absence of a malt liquor policy. We searched online legislative websites and city council proceedings for any local ordinance, regulation, licensing restriction, or condition of sale that restricted the sale or availability of malt liquor, beer, or other malt beverages (use and definition of the term “malt liquor” varies across the country) in off-premise alcohol outlets. We confirmed our findings with local officials. Policies adopted prior to 2004 were disqualified due to data availability and recall bias concerns.

Malt Liquor Policies: Minneapolis

We found six eligible outlet-level policies in Minneapolis, all of which prohibited the sale of single

Table 1 Malt liquor policies in Minneapolis, MN

Outlet	Effective date	Prohibited products
A	2/12/08	1) Single containers of malt liquor or beer 16 oz or less 2) Spirits in bottles under one pint 3) Wine in bottles under 750 ml 4) Non-premium brands of fortified wine
B	9/18/09	1) Single containers of malt liquor or beer 16 oz or less 2) Cash sale of spirits in bottles under one pint 3) Wine in bottles under 750 ml 4) Non-premium brands of fortified wine
C	10/5/07	1) Single containers of malt liquor or beer 16 oz or less 2) Spirits in bottles under one pint 3) Wine in bottles under 750 ml 4) Non-premium brands of fortified wine
D	1/28/05	1) Single containers of malt liquor or beer 16 oz or less 2) Wine or spirits in mini bottles (50 or 100 ml)
E	6/3/05	1) Single containers of malt liquor or beer 18 oz or less 2) Inexpensive fortified wines in half pints or pints 3) Wine in bottles under 750 ml
F	4/15/11	1) Single containers of malt liquor or beer 16 oz or less

containers of malt liquor or beer in containers of 16 to 18 oz or less (Table 1). The policies, adopted between 2005 and 2011, were in the form of operating restrictions placed on the licenses of individual liquor stores on a case-by-case basis. Typically, restrictions are imposed in response to citizen complaints of nuisance activity. Although the Minneapolis policies include restrictions on single containers of beer as well as malt liquor, city licensing staff told us the real intent was to curb high-alcohol malt liquor consumption [36]. All six policies included additional operating restrictions aimed at discouraging public consumption and nuisance behaviors.

Study Areas: Minneapolis Target study areas were created by drawing quarter-mile-radius circles (“buffers”) around outlets with malt liquor policies. The Minneapolis Licenses and Consumer Services Division provided addresses of outlets licensed to sell alcohol from 2002 to 2013. We removed licenses not of interest (e.g., temporary, catering, non-retail) or not in force for the entire study period. We retained no more than one off-premise and one on-premise license per

unique business name and address. Using geographic information systems technology (GIS), we geocoded the outlet addresses and created buffers around each off-premise outlet. We chose a quarter-mile radius in order to reasonably attribute crime effects to the policies being studied. Any buffer that did not have a malt liquor policy or overlap a target buffer was eligible for selection as a comparison.

Matching Target and Comparison Areas: Minneapolis We used a three-step process to match targets with comparisons in Minneapolis. Matching criteria (described below) included alcohol outlet density, demographic attributes, store type, and neighborhood physical characteristics. Social disorganization theories posit that both socioeconomic status and the built environment influence community violence [37–39].

Step 1: Outlet Density and Demographic Attributes

We calculated buffer-level values for outlet density (on- and off-premise), population density, percent males aged 15–29, and percent female-headed households. For each target buffer, we used GIS to spatially join the outlet addresses and block-level census data to the buffer. For outlet density, we counted the number of outlets in each buffer. For demographic attributes, we prorated the block-level census values according to the percentage of each census block falling within the buffer. We then summed these prorated block values to obtain buffer-level values. For each matching criterion, we calculated the number of standard deviations between the target and each comparison candidate. We then summed the standard deviations (SSD) across all matching criteria and selected the ten comparison candidates with the lowest SSD scores. Scores for final comparison buffers ranged from 1 to 6.4 (Table 2), while SSD scores for all other candidates ranged from 2.6 to 13.3.

Step 2: Store Type

The research team viewed images of each target and its ten comparison candidates on Google Street View (GSV), a web-based geographic imaging application. GSV is a reliable proxy for in-person observations [40–45]. The team, by consensus, chose the five best matches for each target based on store type (e.g., matching a liquor store to another liquor store, rather than to a supermarket).

Step 3: Neighborhood Physical Characteristics

We conducted GSV-based audits of each remaining

outlet and surrounding neighborhood using an instrument we developed building on previous research [41–45]. We assessed each outlet according to nearby features, including land use (e.g., commercial versus residential), opportunity to loiter (e.g., adjacent parking lot), building conditions (e.g., boarded windows), street and sidewalk conditions (e.g., potholes), physical disorder (e.g., graffiti), and social disorder (e.g., adult bookstore). We combined these six measures into a single, standardized total score for each outlet, and used these scores to match each target with its three closest comparisons (or four, in the case of a tie). Total scores for targets ranged from 0.9 to 1.6. Total scores for selected comparisons were 0 to 0.3 points from their targets (Table 2), while the scores for other candidates were 0.2 to 0.6 points from their targets (not shown).

We evaluated the inter-source reliability of our GSV-based neighborhood audit instrument and found substantial agreement between measurements from virtual (GSV) versus in-person observations across eight out of ten neighborhood characteristics measured. We assessed inter-rater reliability, finding very good to perfect agreement in scores from two independent raters across seven out of ten characteristics measured. A complete description of our GSV-based matching method is provided elsewhere [43].

Malt Liquor Policies: Washington, D.C.

In Washington, D.C., we found six malt liquor policies in the form of ordinances prohibiting the sale of divided packages and single containers of beer, malt liquor, or ale of 70 oz or less (Table 3). Two of the ordinances also prohibited selling spirits in half pints or less. As in Minneapolis, the policies were a response to citizen complaints of alcohol-related nuisance activities surrounding off-premise alcohol outlets. Unlike the Minneapolis restrictions, which apply to individual outlets on a case-by-case basis, the Washington, D.C. policies apply to all off-premise outlets within a whole or partial ward. In two wards, individual retailers can petition for exemption from the restrictions. The ordinances were enacted during 2007 and 2008 in five of the city's eight wards, as well as in a subdivision of ward 1, Advisory Neighborhood Commission (ANC) 1-D. The five wards, plus ANC 1-D, comprised the six target study areas. The two non-policy wards served as the comparison area for all target areas, with the exception

Table 2 Matching criteria for Minneapolis target and comparison study areas

Study area ^a (outlet buffer)	% Males 15–29	% Female-headed households	Population	Off-premise count	On-premise count	SSD ^b score	GSV ^c score
<i>A</i>	<i>19</i>	<i>21</i>	<i>1453</i>	<i>1</i>	<i>5</i>	<i>0</i>	<i>1</i>
a1	13	13	1104	1	1	1.41	1
a2	31	41	1407	1	1	2.38	1
a3	16	29	1478	3	4	3.07	1
<i>B</i>	<i>19</i>	<i>32</i>	<i>2025</i>	<i>1</i>	<i>4</i>	<i>0</i>	<i>0.9</i>
b1	19	24	1340	1	4	1.2	0.9
b2	31	41	1407	1	1	2.1	1
b3	13	13	1104	1	1	2.54	1
<i>C</i>	<i>18</i>	<i>12</i>	<i>291</i>	<i>3</i>	<i>74</i>	<i>0</i>	<i>0.9</i>
c1	21	14	560	3	44	2.29	0.9
c2	19	0	98	3	9	4.97	0.7
c3	16	29	1478	3	4	6.41	1
<i>D</i>	<i>20</i>	<i>54</i>	<i>1709</i>	<i>2</i>	<i>1</i>	<i>0</i>	<i>1.4</i>
d1	26	56	2101	2	2	1	1.5
d2	24	52	2138	1	0	1.92	1.6
d3	27	40	1604	1	4	2.8	1.3
d4	26	46	964	2	7	2.02	1.6
<i>E</i>	<i>22</i>	<i>41</i>	<i>1007</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>1.6</i>
e1	31	50	824	1	3	1.74	1.3
e2	24	52	2138	1	0	1.88	1.6
e3	27	40	1604	1	4	1.19	1.3
e4	26	46	964	2	7	2.11	1.6
<i>F</i>	<i>28</i>	<i>40</i>	<i>1672</i>	<i>3</i>	<i>3</i>	<i>0</i>	<i>1.2</i>
f1	16	29	1478	3	4	1.58	1
f2	26	42	1548	2	23	2.48	1.2
f3	29	44	2102	2	5	1.81	1.1

^a Targets in italics, followed by comparisons^b Sum of standard deviations of matching criteria from target^c Measure of store and neighborhood characteristics from Google Street View-based audit

of ANC 1-D, where the comparison area was the remainder of ward 1.

Crime

Our dependent variables were monthly crime rates. We obtained the date and location of all crimes known to police for the period 2002–2012 from the Minneapolis and Washington, D.C. police departments. Crime addresses were geocoded and spatially intersected with study areas using GIS technology. The geocoding match rate was 97.2%. We selected crimes for study based on Uniform Crime Reporting (UCR) categories, used by both cities to report standardized statistics to the FBI. The UCR system distinguishes more serious offenses (Part 1) from less serious offenses (Part 2).

In Minneapolis, we evaluated two individual offenses (*Disorderly Conduct* and *Vandalism*), and selected offenses in four crime categories: *Part 1*, *Part 2*, *Assaults*, and *All Crimes*. Selected *Part 1* offenses included homicide, manslaughter, criminal sexual conduct, and aggravated assault. Selected *Part 2* offenses included simple assault, disorderly conduct, narcotics violations, vagrancy/panhandling, vandalism, consuming alcohol in public, and “other offenses” (loitering/lurking, trespassing, drug paraphernalia, and public urination). *Assaults* (including domestics) comprised aggravated assault (involving great bodily harm or a dangerous weapon) and simple assault. *All Crimes* included all of the offenses listed above.

In Washington, D.C., only aggravated assault data were available. The UCR system is voluntary, and the Washington, D.C. police department did not

Table 3 Malt liquor policies in Washington, D.C

Ward	Effective date	Prohibited products
A ^a	12/24/08	1) Divided packages and single containers of malt liquor, beer or ale 70 oz or less
B	12/24/08	1) Divided packages and single containers of malt liquor, beer or ale 70 oz or less. <i>Exceptions allowed</i> 2) Spirits in half pints or less
C	8/1/07	1) Divided packages and single containers of malt liquor, beer or ale 70 oz or less
D	12/25/08	1) Divided packages and single containers of malt liquor, beer or ale 70 oz or less. <i>Exceptions allowed</i> 2) Spirits in half pints or less
E	8/15/08	1) Divided packages and single containers of malt liquor, beer or ale 70 oz or less
F	8/15/08	1) Divided packages and single containers of malt liquor, beer or ale 70 oz or less

^aThe policy affects only part of the ward

consistently report statistics on Part 2 offenses during the study period [46]. Additionally, the department was not able to provide the Part 1 offenses of rape and homicide for the complete study period [47].

Statistical Analysis

To evaluate whether implementation of malt liquor policies were associated with decreases in crime, we compared monthly crime rates in the 3 years prior to, and 3 years following policy adoption, for a total of 72 months of data using time-series modeling. Time-series can model diverse types of serial autocorrelation and provides great flexibility in estimating intervention effects through the use of transfer functions. In addition, by including a local comparison group, effects of other policies and potential covariates can be controlled. In Minneapolis, we fit individual models for each outlet buffer for six crime outcomes: *All Crimes*, *Part 1*, *Part 2*, *Assaults*, *Disorderly Conduct*, and *Vandalism*. In Washington D.C., we ran time-series models for *Aggravated Assaults* only. Crimes over time in the comparison areas (similar areas without malt liquor policies) could be modeled as either outcomes in separate models and estimates differenced to calculate a net effect, or included in the model as a covariate to control for those

changes directly. We chose to model comparison area crimes as time-varying covariates so that these fixed effects would directly control for not only secular trends but also serial autocorrelation.

With a time-series design and a count outcome, the two major analytic complexities were serial autocorrelation and nonnormality. Prior to testing for serial autocorrelation, we excluded any crime outcome with over 50% zeros in the pre-period. We tested each of the remaining 35 outcomes (29 in Minneapolis and 6 in Washington D.C.) for serial autocorrelation, using an autocorrelation check for white noise via an autoregressive integrated moving average (ARIMA) model [48]. Of these, over half showed positive serial autocorrelation. For these, we modeled monthly crime counts using an ARIMA time-series model. We log-transformed the count data to improve the distribution and allow model parameter estimates to be interpreted as percent change. We controlled for seasonality and nonstationarity where indicated.

For the 13 outcomes lacking serial autocorrelation, ARIMA models were not necessary. For these, we used negative binomial regression, as overdispersion was indicated and therefore Poisson regression was not appropriate. To compare the ARIMA and negative binomial results, we transformed effect estimates into percent change estimates. We used SAS® software, version 9.3 [48] for all analyses using either PROC ARIMA or PROC GENMOD. A strict significance criterion of P less than 0.05 (two-tailed test) was used to evaluate the effect of malt liquor policy adoption.

Results

Monthly Crime Rates

Unadjusted monthly crime rates in Minneapolis varied widely across study areas and crime categories (Table 4). Across study areas, average monthly pre-period counts of *All Crimes* ranged from 2.9 in a middle-class, residential neighborhood to 231.7 in a downtown area. Across crime categories, the more serious *Part 1* crimes were rare, as expected, ranging from 1.1 to 9.3 per month in the pre-policy period. *Part 2* crimes ranged from 2.8 to 222.3 per month in the same period. Total unadjusted crime rates, in all target

Table 4 Change in monthly crime rates following malt liquor policy adoption, Minneapolis, MN

Crime	Study area (outlet buffer)	Average monthly crimes in pre-period	Estimated percent change after policy adoption ^a	Estimated change in number of crimes ^a	<i>p</i> value
All Crimes	A ^b	2.9	-42.9	-1.2	0.003
	B	16.3	-56.0	-9.1	<.0001
	C	231.7	3.3	7.7	0.63
	D	42.6	8.5	3.6	0.72
	E	8.7	9.3	0.8	0.41
	F	9.1	13.1	1.2	0.46
Part 1	A ^c	*	*	*	*
	B ^c	*	*	*	*
	C ^b	9.3	-20.4	-1.9	0.01
	D	4.6	15.2	0.7	0.19
	E ^b	1.1	49.1	0.5	0.06
	F ^b	1.1	-12.3	-0.1	0.66
Part 2	A	2.8	-12.6	-0.4	0.27
	B	15.7	-59.0	-9.3	<.0001
	C	222.3	1.8	3.9	0.56
	D	37.9	9.4	3.6	0.53
	E	7.6	3.5	0.3	0.79
	F	8.0	16.6	1.3	0.38
Assaults	A ^c	*	*	*	*
	B ^b	2.1	-12.3	-0.3	0.58
	C	30.0	-13.5	-4.1	0.002
	D	12.0	8.7	1.0	0.40
	E ^b	4.0	11.5	0.5	0.35
	F ^b	3.1	27.8	0.9	0.21
Disorderly conduct	A ^c	*	*	*	*
	B ^c	*	*	*	*
	C	37.5	0.4	0.1	0.96
	D ^b	2.9	-5.5	-0.2	0.69
	E ^c	*	*	*	*
	F ^c	*	*	*	*
Vandalism	A ^b	1.8	-51.7	-0.9	0.002
	B ^b	2.7	-25.6	-0.7	0.07
	C	13.6	-24.4	-3.3	0.004
	D	6.2	-6.6	-0.4	0.64
	E ^b	3.4	-5.0	-0.2	0.74
	F ^b	2.3	41.5	1.0	0.09

^a After controlling for pre-post change in comparison areas^b Negative binomial model^c Model not run due to numerous zero crime counts

and comparison study areas combined, decreased from the pre-period to the post-period in all categories except *Disorderly Conduct*.

In Washington, D.C., average monthly *Aggravated Assaults* during the pre-period ranged from 27.3 to 60.0, not including area A, a partial ward (Table 5). Total unadjusted *Aggravated Assault* rates, in all target and

comparison study areas combined, increased from the pre-period to the post-period.

Effects of Malt Liquor Policy Restrictions on Crime

Minneapolis We hypothesized that adoption of malt liquor sales restrictions would be associated with

Table 5 Change in monthly crime rates following malt liquor policy adoption, Washington, D.C

Crime	Study area (ward)	Average monthly crimes in pre-period	Estimated percent change after policy adoption ^a	Estimated change in number of crimes ^a	<i>p</i> value
Aggravated Assaults	A	3.3	-30.1	-1.0	0.05
	B	28.0	-8.4	-2.3	0.19
	C ^b	27.3	8.1	2.2	0.12
	D	38.3	4.1	1.6	0.36
	E	48.5	4.3	2.1	0.61
	F	60.0	4.8	2.9	0.40

^a After controlling for pre-post change in comparison areas^b Negative binomial model

decreases in crime in neighborhoods surrounding affected outlets after controlling for crime around outlets with no restrictions. Tests for the effect of malt liquor policies were in the hypothesized direction in 14 of the 29 Minneapolis models run (Table 4). Statistically significant differences were found in seven of the models, all in the hypothesized direction. Examining results by crime category, *Part 1*, *Part 2*, and *Assaults* each had one statistically significant test. *Vandalism* decreased in five of the six study areas, with two of these estimates statistically significant. *Disorderly Conduct* was common enough to estimate in only two study areas, and neither was statistically significant.

Results varied by study area, as illustrated in Fig. 1. The study area around Outlet C had significant reductions in three crimes: *Part 1*, *Assaults*, and *Vandalism*. Two study areas each had significant reductions in two crimes: *All Crimes* and *Vandalism* around outlet A and *All Crimes* and *Part 2* around outlet B. It is important to note that the *All Crimes*, *Part 1*, and *Part 2* categories incorporate other crime categories and are therefore not independent.

Washington, D.C. Target areas showed few changes in *Aggravated Assaults* following adoption of malt liquor restrictions (Table 5). Tests were in the hypothesized direction in just two of the six study areas, with only one significant change. Specifically, the partial ward comprising area A showed a statistically significant relative decrease of 30.1% ($p = .05$) in *Aggravated Assaults* following malt liquor policy adoption. (As mentioned earlier, crime increased in Washington, D.C. during this

period, so this 'adjusted decrease' actually represents a smaller increase in the target relative to the comparison.) None of the other tests were statistically significant.

Discussion

We evaluated the impact of single-container malt liquor sales restrictions on crime in Minneapolis, Minnesota, and Washington, D.C. We found evidence that these restrictions were associated with modest reductions in a range of crimes associated with alcohol.

In Minneapolis, crime decreased in three of six study areas. Drinkers in these areas may have purchased less malt liquor due to the restrictions, and hence, were less inebriated and less likely to engage in nuisance behaviors. It is also possible that drinkers went elsewhere to purchase malt liquor, possibly increasing crime levels in that neighborhood. However, Tarnai found that alcohol-related problems did not migrate to other neighborhoods following imposition of a ban on cheap, high-alcohol malt beverage and wine sales in Alcohol Impact Areas in Seattle, Washington [3].

The only Minneapolis study area to show a significant decrease in the more serious *Part 1* crimes was a downtown area (around outlet C). Assaults and vandalism also decreased there. As shown in Table 2, this study area has three liquor stores, 74 on-premise outlets (nightclubs, bars, and restaurants), and a professional sports arena, but only 291 residents. These conditions provide an opportunity for large numbers of transient drinkers to come into contact with one another under limited community supervision, increasing the risk for violence [49]. This, coupled with the stronger law enforcement presence downtown, may have contributed to the reduction in *Part 1* crimes.

The Minneapolis restriction was not particularly strong, in that it addressed only single containers of malt liquor of 16 oz or less, but not larger singles, such as 32- and 40-oz bottles. The larger bottles have been the focus of community complaints, and are abundant in liquor stores in low-income areas of Minneapolis [24]. Malt liquor restrictions are often imposed concurrently with other policies intended to deter crime, such as limits on hours of sale, or requiring video cameras. It is worth noting that the three outlets where crime decreased were also prohibited from selling non-premium fortified wine and half-pints of spirits,

Fig. 1 Impact of malt liquor policy on crime

products that are both low cost, high-alcohol products that could be substituted for malt liquor (Table 1). These three outlets were also the only targets required to prevent loitering and panhandling outside their stores (data not shown). This

combination of policies may have been more effective than single-container restrictions alone.

In Washington, D.C., a somewhat stronger policy prohibited single containers of any size, and covered all outlets within a full or partial ward. Here, we saw

statistically significant decreases only in area A. The area includes a commercial corridor with high outlet density and high rates of alcohol-related crime. A temporary single-sales moratorium imposed along the corridor in 1999 had garnered strong community support, and was generally perceived as successful by residents, police, and even many business owners [50–53]. This support may have encouraged retailer compliance when the more broad-based, permanent ordinance was adopted in 2008.

We found no association between policy adoption and crime reduction in the majority of study areas in Minneapolis and Washington, D.C. Crime may be unrelated to malt liquor consumption in these areas, or policy effects may have been too small to detect. This is especially likely in Washington, D.C., where wards include large areas of affluence within which high-alcohol malt liquor consumption was not likely a problem even before policy adoption.

Finally, retailers may simply have failed to comply with the policy. In one Washington, D.C. ward (area C), liquor retailers challenged a permanent moratorium on single sales in 2004 and successfully obtained an injunction to stop it. The moratorium ultimately took effect in 2007 when the injunction was overturned on appeal. However, the lawsuit and attendant delay in policy implementation may have resulted in reduced levels of compliance when the policy finally did take effect. While difficult to achieve in a retrospective study, future research on this topic should address compliance and enforcement. Lax enforcement was a major theme in an earlier case study we conducted in cities that had adopted malt liquor policies [2].

In summary, our results suggest at least some policy effects on crime reduction at both the individual outlet level and the area level. The policies may work best in combination with other policies, such as restrictions on malt liquor substitutes (e.g., fortified wine and small bottles of spirits). Finally, the contrasting experiences of areas A and C in Washington, D.C. suggest that strong community support for local alcohol policies is important to their success over time. This may be especially true for area-wide policies, which, due to their scale, are more likely to attract organized opposition from the alcohol industry.

Limitations

The following limitations of our study should be noted. Although the UCR system has standardized crime

reporting to some extent, data are not always collected uniformly in all cities over time. Several crimes we hoped to assess were not consistently reported in Washington, D.C. during our study period. Furthermore, in Minneapolis, counts for some crimes of interest (e.g., public drinking, panhandling, and loitering) were too low to evaluate separately. Stronger effects may have been observed in cities with higher crime levels and complete crime data.

Malt liquor policies are a small signal in a “noisy” environment. Localized changes over time in enforcement priorities or criminal influences (e.g., the emergence of a new street gang) could affect crime rates in some parts of the city, but not others. We used multiple targets and matched comparisons to reduce these influences and help isolate the policy effect. Finally, some single-container restrictions were adopted with additional policies that may have influenced crime rates, and some outlets in Washington, D.C. had pre-existing voluntary agreements to refrain from selling singles. We were not able to separate these effects with a time-series design.

Implications

To our knowledge, this is the first study to rigorously evaluate the effects on crime of single-container malt liquor sales restrictions at two levels of implementation. Evaluating local alcohol policies can be a complex undertaking due to lack of data and intra-city differences. However, our results provide evidence that single-sales restrictions, even relatively weak ones, may have modest effects on a range of crimes. This finding is interesting, given local malt liquor restrictions are typically just one small component of the broader alcohol-control environment.

Acknowledgement This research was supported by funding from the National Institute on Alcohol Abuse and Alcoholism, grant number R01AA020496.

References

1. Jones-Webb R, McKee P, Toomey T, et al. Regulating malt liquor in urban areas in the United States. *Contemp Drug Probl.* 2011; 38(1): 41–59.
2. McKee PA, Nelson TF, Toomey TL, Shimotsu ST, Hannan PJ, Jones-Webb RJ. Adopting local alcohol policies: a case

- study of community efforts to regulate malt liquor sales. *Am J Health Promot.* 2012; 26(3): e86–e94.
3. Tarnai J. Post-assessment Seattle, Washington Alcohol Impact Areas (Report No. 09–032). Pullman, Washington: Washington State University 2009. [Accessed online 2016 Feb 25]. Available from: http://www.liq.wa.gov/publications/AlcImpactAreas/2009_Final_Report.pdf
 4. Tarnai J. Evaluation of the Tacoma, Washington, Alcohol Impact Area (AIA). Pullman, WA: Social & Economic Sciences Research Center at Washington State University 2003. [Accessed online 2016 Feb. 25]. Available from: http://www.liq.wa.gov/publications/AlcImpactAreas/2003_Report.pdf
 5. Marchetti T. Proposed Alcohol Impact Area, Portland Downtown Core Summary Report. Office of Neighborhood Involvement Liquor Licensing Program, August 2010. [Accessed online 2016 Feb 15]. Available from: <https://www.portlandoregon.gov/oni/53286>.
 6. Sampson RS. Tackling crime and other public-safety problems: case studies in problem-solving. Washington, DC: US Department of Justice, Office of Community Oriented Policing Services 1999. [Accessed online 2016 Feb 15]. Available from: http://www.cops.usdoj.gov/html/cdrom/inaction1/Problem_Solving_Case_Study_toc_f.htm.
 7. Alcohol Epidemiology Program, University of Minnesota. Local Malt Liquor Policies. [accessed online 2016 February]. Available from: <http://www.aep.umn.edu/index.php/aep-tools/malt-liquor/>.
 8. National Institute on Alcohol Abuse and Alcoholism. Drinking levels defined. 2015. [Accessed online 2015 May]. Available from: <http://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/moderate-binge-drinking>.
 9. Pridemore WA. Weekend effects of binge drinking and homicide: the social connection between alcohol and violence in Russia. *Addiction.* 2004; 99(8): 1034–1041.
 10. Richardson A, Budd T. Young adults, alcohol, crime and disorder. *Crim Behav Ment Health.* 2003; 13(1): 5–16.
 11. Parker RN, McCaffree KJ, Skiles D. The impact of retail practices on violence: the case of single serve alcohol beverage containers. *Drug Alcohol Rev.* 2011; 30: 496–504.
 12. Hoke O, Cotti C. The impact of large container beer purchases on alcohol-related fatal vehicle accidents. *Contemp Econ Policy.* 2015; 33(3): 477–487.
 13. Campbell CA, Hahn RA, Elder R, 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(6): 556–569.
 14. Gruenewald PJ, Remer L. Changes in outlet densities affect violence rates. *Alcohol Clin Exp Res.* 2006; 30(7): 1184–1193.
 15. Paschall M, Lippman-Kreda S, Grube JW. Effects of the local alcohol environment on adolescents' drinking behaviors and beliefs. *Addiction.* 2014; 109(3): 407–416.
 16. Zhu L, Gorman DM, Horel S. Alcohol outlet density and violence: a geospatial analysis. *Alcohol Alcohol.* 2004; 39(4): 369–75.
 17. Britt HR, Carlin BP, Toomey TL, Wagenaar AC. Neighborhood level spatial analysis of the relationship between alcohol outlet density and criminal violence. *Environ Ecol Stat.* 2005; 12(4): 411–426.
 18. Hill TD, Angel RJ. Neighborhood disorder, psychological distress, and heavy drinking. *Soc Sci Med.* 2005; 61(5): 965–975.
 19. Murray RK, Roncek DW. Measuring diffusion of assaults around bars through radius and adjacency techniques. *Crim Justice Rev.* 2008; 33(2): 199–220.
 20. Bluthenthal RN, Brown-Taylor D, Guzmán-Becerra N, Robinson PL. Characteristics of malt liquor beer drinkers in a low-income, racial minority community sample. *Alcohol Clin Exp Res.* 2005; 29(3): 402–409.
 21. Vilamovska A, Brown-Taylor D, Bluthenthal RN. Adverse drinking-related consequences among lower income, racial, and ethnic minority drinkers: cross-sectional results. *Alcohol Clin Exp Res.* 2009; 33(4): 645–653.
 22. Bradizza CM, Collins RL, Vincent PC, Falco DL. It does the job: young adults discuss their malt liquor consumption. *Addict Behav.* 2006; 31(9): 1559–1577.
 23. Chen M, Paschall MJ. Malt liquor use, heavy/problem drinking and other problem behaviors in a sample of community college students. *J Stud Alcohol.* 2003; 64(6): 835–842.
 24. Jones-Webb R, McKee P, Hannan P, et al. Alcohol and malt liquor availability and promotion and homicide in inner cities. *Subst Use Misuse.* 2008; 43(2): 159–177.
 25. Parker RN. Alcohol and violence: connections, evidence and possibilities for prevention. *J Psychoactive Drugs.* 2004; 36(sup2): 157–163.
 26. Babor T, Caetano R, Casswell S, et al. *Alcohol: no ordinary commodity: research and public policy.* Oxford/London: Oxford University Press; 2003.
 27. Nelson TF, Xuan Z, Babor TF, et al. Efficacy and the strength of evidence of U.S. alcohol control policies. *Am J Prev Med.* 2013; 45(1): 19.
 28. Mosher JF, Saetta SL. *Best practices in municipal regulation to reduce alcohol-related harms from licensed alcohol outlets.* Center for the Study of Law and Enforcement Policy, Pacific Institute for Research and Evaluation. Ventura: Ventura County Behavioral Health Department Publication: Thousand Oaks, California; 2008.
 29. Heaton P. Sunday liquor laws and crime. *J Public Econ.* 2012; 96(1–2): 42–52.
 30. Hahn R, Kuzara J, Elder R, et al. Effectiveness of policies restricting hours of alcohol sales in preventing excessive alcohol consumption and related harms. *Am J Prev Med.* 2010; 39(6): 590–604.
 31. Mosher JF, Treffers RD. State pre-emption, local control, and alcohol retail outlet density regulation. *Am J Prev Med.* 2013; 44(4): 399–405.
 32. Stockwell T, Gruenewald P. Controls on the physical availability of alcohol. In: *The Essential Handbook of Treatment and Prevention of Alcohol Problems.* Heather N, Stockwell T, eds. Wiley Publishers: Chichester, West Sussex, England; 2004. p. 213–233.
 33. Barajas E, McKee P, Hannan PJ, Nelson TF, Jones-Webb R. Effects of policies to restrict malt liquor sales on neighborhood crime. *Subst Use Misuse.* 2011; 46(10): 1234–1243.
 34. U.S. Census Bureau. Quick Facts. 2010 [Accessed online 2015 Jun 4]. Available from: <http://quickfacts.census.gov>.
 35. Shadish WR, Cook TD, Campbell DT. *Experimental and quasi-experimental designs for generalized causal inference (2nd edition).* Houghton Mifflin: Boston, Massachusetts; 2002.
 36. Schliesman PL. As told to Mark Miazga. 2008.

37. Sampson R, Raudenbush S. Systematic social observation of public spaces: a new look at disorder in urban neighborhoods. *Am J Social.* 1999; 105(3): 603–651.
38. Skogan W. Communities, crime, and neighborhood organization. *Crime Delinq.* 1989; 35(3): 437–457.
39. Milam AJ, Furr-Holden CD, Harrell PT, Whitaker DE, Leaf PJ. Neighborhood disorder and juvenile drug arrests: a preliminary investigation using the NIfETy instrument. *Am J Drug Alcohol Abuse.* 2012; 38(6): 598–602.
40. Ben-Joseph E, Lee JS, Cromley EK, Laden F, Troped PJ. Virtual and actual: relative accuracy of on-site and web-based instruments in auditing the environment for physical activity (Report). *Health Place.* 2013; 19: 138.
41. Griew P, Hillsdon M, Foster C, Coombes E, Jones A, Wilkinson P. Developing and testing a street audit tool using Google Street View to measure environmental supportiveness for physical activity. *Int J Behav Nutr Phys Act.* 2013; 10: 103.
42. Kelly CM, Wilson J, Baker E, Miller D, Schootman M. Using google street view to audit the built environment: inter-rater reliability results. *Ann Behav Med.* 2013; 45: S108–S112.
43. Levine Less E, McKee P, Toomey TL, et al. Matching study areas using Google Street View: a new application for an emerging technology. *Eval Program Plann.* 2015; 53: 72–79.
44. Odgers CL, Caspi A, Bates CJ, Sampson RJ, Moffitt TE. Systematic social observation of children's neighborhoods using Google Street View: a reliable and cost-effective method. *J Child Psychol Psychiatry.* 2012; 53(10): 1009–1017.
45. Rundle AG, Bader M, Richards C, Neckerman K, Teitler J. Using Google Street View to audit neighborhood environments. *Am J Prev Med.* 2011; 40(1): 94–100.
46. Eich B. Email to Patricia McKee. 2012 Oct 1.
47. Goodison S. Email to Patricia McKee. 2013 Jun 21.
48. SAS Institute, Inc. Base SAS® 9.3 Procedures Guide: Statistical Procedures. Cary, NC 2011.
49. Gouvis Roman C, Reid SE, Bhati AS, Tereshchenko B. Alcohol Outlets as Attractors of Violence and Disorder. U.S. Department of Justice 2008. [Accessed online 2016 Feb 29] Available from: <https://www.ncjrs.gov/pdffiles1/nij/grants/227646.pdf>.
50. Lane T. Mt. Pleasant Debate Renewing 4-year Single Sales Beer Ban. The InTowner. 2005 Feb. [Accessed online 2016 Feb 25]. Available from: http://thesitehub.com/InTowner_archive/2005February.pdf.
51. Emerling G. Single-beer sales ban proposed for H Street. The Washington Times. 2007 Mar 14. [Accessed online 2016 Feb 25]. Available from: <http://www.washingtontimes.com/news/2007/mar/13/20070313-103651-3001r/?page=al>.
52. Collins L. Viewpoint: what we have learned in Mt. Pleasant. The Northwest Current. 2008 Feb 20. [Accessed online 2016 Feb 25]. Available from: <http://www.currentnewspapers.com/admin/uploadfiles/NW%20Feb.%2020%20Pgs.%201-22%201.pdf>.
53. Gould J. Take It Inside: authorities target outdoor drinking on a booming stretch of H street. Washington City Paper. 2007 Jan 26. [Accessed online 2016 Feb 25]. Available from: <http://www.washingtoncitypaper.com/articles/536/take-it-inside>.