Alcohol Policies and Alcohol-Involved Homicide Victimization in the United States

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ABSTRACT. Objective: The purpose of this study was to examine the associations between the alcohol policy environment and alcohol involvement in homicide victims in the United States, overall and by sociodemographic groups. **Method:** To characterize the alcohol policy environment, the presence, efficacy, and degree of implementation of 29 alcohol policies were used to determine Alcohol Policy Scale (APS) scores by state and year. Data about homicide victims from 17 states from 2003 to 2012 were obtained from the National Violent Death Reporting System. APS scores were used as lagged exposure variables in generalized estimating equation logistic regression models to predict the individual-level odds of alcohol involvement (i.e., blood alcohol concentration [BAC] > 0.00% vs. = 0.00% and BAC ≥ 0.08% vs. ≤ 0.079%) among homicide victims. **Results:** A 10 percentage point increase in

APS score (representing a more restrictive policy environment) was associated with reduced odds of alcohol-involved homicide with BAC greater than 0.00% (adjusted odds ratio [AOR] = 0.89, 95% CI [0.82, 0.99]) and BAC of 0.08% or more (AOR = 0.91, 95% CI [0.82, 1.02]). In stratified analyses of homicide victims, more restrictive policy environments were significantly protective of alcohol involvement at both BAC levels among those who were female, ages 21–29 years, Hispanic, unmarried, victims of firearm homicides, and victims of homicides related to intimate partner violence. **Conclusions:** More restrictive alcohol policy environments were associated with reduced odds of alcohol-involved homicide victimization overall and among groups at high risk of homicide. Strengthening alcohol policies is a promising homicide prevention strategy. (*J. Stud. Alcohol Drugs*, 78, 781–788, 2017)

ALCOHOL IS THE MOST WIDELY USED psychoactive drug consumed in the United States (National Council on Alcoholism and Drug Dependence, 2015). Excessive alcohol consumption is the third leading preventable cause of death in the United States and is strongly associated with violent death and other forms of premature mortality (Bouchery et al., 2011; Darke, 2010; Heron, 2012; Mokdad et al., 2004; Naimi et al., 2009). Alcohol is a contributing factor in 40% of all violent crimes in the United States, and two meta-analyses of homicides both in the United States and internationally (including studies of European nations, South Africa, and Australia) found alcohol to be present in approximately 50% of perpetrators (Kuhns et al., 2014) and 48% of victims (Kuhns et al., 2011). Alcohol use may be related to homicide victimization because potential victims who drink may be around others who are drinking, because alcohol use may affect behaviors that put a person at increased risk for homicide

victimization, or both (Darke, 2010). A recent analysis of 17 U.S. states from 2003 to 2012 using data from the National Violent Death Reporting System (NVDRS) found that 39.9% of homicide victims had a positive blood alcohol concentration (BAC), including 26.2% of victims with a BAC of 0.08% or greater (Naimi et al., 2016). When considering alcohol involvement in homicide victimization, significant differences exist in the prevalence of alcohol involvement across sociodemographic groups (e.g., gender), precipitating factors (e.g., prior substance abuse problems), and circumstances (e.g., firearm involvement) (Naimi et al., 2016).

Despite considerable prior research about alcohol involvement in homicide, relatively little is known about the relationships between alcohol policies and alcohol-involved homicides. In the United States, alcohol policies vary substantially between states (Naimi et al., 2014). Examples of state alcohol policies include alcohol excise taxes; regulating the location, time, and quantity of alcohol sales; and restricting retail signage and media advertising (Nelson et al., 2013). No previous study has examined alcohol-involved homicides in relation to the overall policy “environment” (i.e., based on the effect of multiple policies in place) (Nelson et al., 2013) and homicide victimization. Our research team has previously shown that more restrictive policy environments are associated with lower odds of binge drinking among

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youth and adults, alcoholic cirrhosis, and alcohol-related motor vehicle crash fatalities (Hadland et al., 2015, 2016; Naimi et al., 2014; Xuan et al., 2015a, 2015b, 2015c).

In addition, increased restrictiveness of some specific state-level alcohol policies has been linked to decreased alcohol-related violence, including homicide. For example, studies of minimum legal drinking age policies have found that increasing the drinking age to 21 has reduced death rates by homicide in adolescents and young adults (Birckmayer & Hemenway, 1999; Grucza et al., 2012; Jones et al., 1992). Most studies that have assessed the association between alcohol policy and homicide have examined single policies or have studied this relationship in single locations (e.g., Chicago, Baltimore) and have not specifically studied characteristics that increase or decrease the odds of alcohol involvement in homicide victimization (Hahn et al., 2010; Jennings et al., 2014; Jones-Webb et al., 2008; Malaga et al., 2012; Parker et al., 2011; Wagenaar et al., 2009). However, the extent to which the overall alcohol policy environment as reflected by multiple policies of varying efficacy and levels of implementation in a state may affect alcohol-involved homicides has not been examined previously but is crucially important for future policy development, policy implementation, and the prevention of alcohol-involved homicides.

The objective of this study was to identify the relationship between the alcohol policy environment and the prevalence of alcohol-involved homicides using data from the NVDRS. We hypothesized that stronger (i.e., more restrictive) alcohol policy environments would be associated with reduced odds of alcohol involvement in homicide victimization.

Method

Measuring the alcohol policy environment

The alcohol policy environment was operationalized using the Alcohol Policy Scale (APS), a previously validated tool that assesses implementation and efficacy of alcohol policies in all 50 states and Washington, DC, from 1999 to 2012 (Naimi et al., 2014; Nelson et al., 2013). The APS was developed with the input of a panel of 10 alcohol policy experts representing multiple disciplines including law, sociology, economics, epidemiology, and psychology.

Panelists initially nominated 47 alcohol policies from the Alcohol Policy Information System from the National Institute on Alcohol Abuse and Alcoholism (2013) and 18 other data sources for potential inclusion in the APS (Naimi et al., 2014). Of these policies, the investigators excluded those that were not implemented in the United States (e.g., BAC 0.05% laws); were promulgated at the federal level (e.g., restrictions on mass media advertising); did not vary across states (e.g., public intoxication laws); and lacked reliable data across states (e.g., laws that require mandatory assessment for driving under the influence). Data on 29 policies

were used to calculate APS scores (Nelson et al., 2013). We used only policy data sources that collected information on a particular policy across all states to preclude the possibility of state-specific differences in interpretation or reporting.

A modified Delphi approach was used in which panelists drew upon available scientific literature and their expert opinion to independently assess each of the policies in regard to their relative efficacy in reducing excessive drinking or alcohol-related harm. Panelists used a 5-point Likert scale (1 = *low efficacy*, 5 = *high efficacy*) to rate each policy. As a last step, the panelists met as a group to discuss their ratings and evidence supporting each policy before independently rating each policy a second time. The mean values of the second set of ratings then became the efficacy scores for each of 29 policies. Efficacy ratings for enacted policies did not vary by state-year.

Panelists also rated each policy based on the degree of legislative implementation for each policy for each state and year; for each policy the same implementation rating metric was applied to all state-years. The study investigators first designed an implementation rating metric for each policy that incorporated provisions that made policies applicable, effective, or enforceable at reducing excessive drinking or alcohol-related harm (Naimi et al., 2014).

To calculate an overall APS score for each state and year, present policies were summed after weighting each policy by its efficacy score and implementation rating (Naimi et al., 2014; Nelson et al., 2013). In previous work, we examined the goodness-of-fit of scores based on several possible methods of aggregation to determine the best measure to predict excessive drinking and related harms, and that measure was used for this study (Naimi et al., 2014). Study investigators standardized the APS scores on a scale from 0 to 100, based on the theoretical minimum and maximum scores. Higher APS scores represented more restrictive alcohol policy environments.

Measuring homicide victimization

This study used data from NVDRS from 2003 to 2012. NVDRS is a population-based active surveillance system operated by the Centers for Disease Control and Prevention (CDC) that provides information about all violent deaths that occur among residents and nonresidents of participating U.S. states. Each victim record includes information about the victim, suspect(s), the relationship of the victim to the suspect(s), toxicology results for the victim (if available), and any weapon(s) that were involved in the incident. Required primary sources of NVDRS data include death certificates, coroner/medical examiner records including toxicology reports, and other law enforcement reports (CDC, 2015). Secondary sources include Child Fatality Review team data (report includes case status and death scene information, suspect and family member criminal histories,

TABLE 1. Mean alcohol policy score and range, mean blood alcohol concentration (BAC) testing rate, and prevalence of alcohol involvement among homicide victims by BAC and state, National Violent Death Reporting System, 2003–2012

State (no. of homicides with BAC testing)	APS ^a (min., max.)	M BAC testing	Alcohol-involved homicides (BAC > 0.00%) (n = 10,377)	Alcohol-related homicides (BAC ≥ 0.08%) (n = 6,575)
Utah (423)	66.1 (64.8, 68.4)	97.4%	25.8% (109)	18.7% (79)
Oklahoma (1,933)	60.9 (58.3, 62.3)	90.2%	33.6% (650)	25.0% (484)
New Mexico (1,108)	53.2 (52.8, 54.0)	90.9%	48.3% (535)	34.9% (387)
Oregon (462)	49.2 (47.3, 49.6)	41.0%	47.8% (221)	27.7% (128)
Massachusetts (1,418)	47.5 (46.1, 49.4)	78.9%	41.5% (589)	22.3% (316)
Ohio (690)	44.3 (44.0, 44.7)	53.3%	41.5% (286)	24.5% (169)
Georgia (2,683)	43.7 (43.1, 44.2)	42.3%	28.1% (754)	18.4% (494)
North Carolina (4,808)	43.3 (40.9, 45.9)	88.1%	35.3% (1,699)	24.8% (1,193)
Virginia (3,719)	42.9 (40.7, 45.7)	95.4%	36.4% (1,353)	21.5% (799)
Kentucky (1,074)	42.5 (41.9, 43.6)	68.4%	32.9% (353)	23.6% (253)
New Jersey (521)	41.0 (39.1, 41.9)	12.7%	66.4% (346)	34.0% (177)
Rhode Island (270)	40.8 (39.7, 41.5)	96.0%	33.3% (90)	21.1% (57)
South Carolina (631)	40.1 (36.2, 43.8)	17.5%	97.3% (614)	60.4% (381)
Alaska (221)	39.1 (34.5, 41.6)	60.0%	76.5% (169)	66.5% (147)
Colorado (1,231)	35.6 (33.4, 37.9)	71.4%	49.4% (608)	32.7% (403)
Maryland (4,547)	33.7 (30.8, 34.8)	93.5%	34.2% (1,556)	17.7% (806)
Wisconsin (1,235)	31.7 (29.6, 32.9)	79.8%	36.0% (445)	24.5% (302)

Notes: No. = number. ^aAlcohol Policy Scale score, based on the mean of APS scores across all study years. The minimum (min.) and maximum (max.) APS scores by state pertain to the state-years of data analyzed in the study.

expertise on law enforcement practices, and information from any other law enforcement agencies); intimate partner violence—expanded data; crime lab data; and hospital medical records (CDC, 2015).

Statistical analysis

We calculated prevalence rates (presented as percentages) of alcohol-involved homicides at both BAC levels greater than 0.00% and of 0.08% or more (Table 1). Homicide data were not weighted, as our sample included a census of all reported homicides from participating states.

We used generalized estimating equations (GEE) logistic models to determine the association between APS scores and the individual-level odds of alcohol involvement among homicide victims, while accounting for state- and individual-level covariates, year, and state-year BAC testing rate. The GEE models were fit using alternating logistic regression to account for clustering within states and also counties nested within states (Carey et al., 1993), because of homicide clusters at the county level noted in prior research (Messner et al., 1999). Robust standard errors are reported for all models. We calculated odds ratios (ORs), adjusted ORs, and 95% confidence intervals (CI) for the odds of alcohol involvement (BAC > 0.00% vs. = 0.00%, and BAC ≥ 0.08% vs. BAC ≤ 0.079%) among homicides in relation to APS score by state-year, overall and among various strata of victims. Because there may be a delay between policy enactment and policy implementation, and because our previous research found slightly improved goodness of fit, we analyzed data using a 1-year lag. For example, APS scores from 2009 were

analyzed in relation to homicides that occurred in 2010. We also conducted a sensitivity analysis using no lag between policies and homicides.

In adjusted models, we accounted for state- and individual-level factors that have been identified as being associated with homicide in the scientific literature. State-level covariates included the proportion of males; the proportion of individuals 21 years of age and older; the proportion of non-Hispanic Whites, non-Hispanic Blacks, Hispanics, and other races/ethnicities; the proportion of individuals with a college degree or above; the proportion of individuals that were unemployed; median family income; police rate per 100,000 population; the degree of urbanization (defined as the proportion of individuals living in urban census blocks); and religious composition (defined as the proportion of Catholic adherents). Individual-level covariates included age, sex, race/ethnicity (Black non-Hispanic, White non-Hispanic, Hispanic, American Indian/Alaska Native non-Hispanic, other), marital status (defined as married/civil union, unmarried [single, separated, divorced, widowed]); and whether the victim was known to have a mental health problem (the victim was identified as having a mental health problem other than an alcohol or substance abuse problem, according to DSM-IV classification; CDC, 2015).

To assess whether APS associations with the individual-level odds of alcohol involvement among homicide victims were related to the impact of policies on state-level per capita alcohol consumption, we assessed per capita alcohol consumption as a potential mediator of this relationship. Although it would have been ideal to use information about alcohol consumption (and binge drinking in particular) for

TABLE 2. Adjusted odds ratios^a (AORs) of alcohol involvement among homicide victims associated with a 10 percentage point increase in the Alcohol Policy Scale (APS) score,^b National Violent Death Reporting System, 2003–2012

Variable	Overall AOR [95% CI]	Men AOR [95% CI]	Women AOR [95% CI]
Models testing odds of alcohol involvement			
BAC > 0.00% vs. 0.00%			
Unadjusted GEE Model	0.96 [0.90, 1.03]	0.96 [0.89, 1.02]	0.94 [0.86, 1.03]
Adjusted GEE Model I ^c (individual-level covariates)	0.92 [0.87, 0.98]*	0.91 [0.85, 0.97]*	0.92 [0.84, 1.02]
Adjusted GEE Model II ^d (individual- and state-level covariates)	0.82 [0.76, 0.87]*	0.81 [0.75, 0.87]*	0.80 [0.71, 0.90]*
Adjusted GEE Model III ^e (further controls for year)	0.84 [0.76, 0.92]*	0.83 [0.75, 0.92]*	0.79 [0.68, 0.92]*
Adjusted GEE Model IV ^f (further controls for BAC testing rate)	0.89 [0.82, 0.99]*	0.89 [0.80, 0.98]*	0.85 [0.72, 0.99]*
Models testing odds of alcohol involvement			
BAC ≥ 0.08% vs. ≤ 0.079%			
Unadjusted GEE Model	1.03 [0.96, 1.11]	1.02 [0.93, 1.11]	1.05 [0.93, 1.17]
Adjusted GEE Model I (individual-level covariates)	0.98 [0.91, 1.05]	0.97 [0.89, 1.05]	1.01 [0.90, 1.13]
Adjusted GEE Model II (individual-and state-level covariates)	0.88 [0.79, 0.98]*	0.89 [0.79, 0.99]*	0.82 [0.71, 0.94]*
Adjusted GEE Model III (further controls for year)	0.87 [0.79, 0.97]*	0.89 [0.80, 0.99]*	0.73 [0.61, 0.86]*
Adjusted GEE Model IV (further controls for BAC testing rate)	0.91 [0.82, 1.02]	0.93 [0.83, 1.04]	0.74 [0.63, 0.88]*

Notes: BAC = blood alcohol concentration; GEE = generalized estimating equations; CI = confidence interval. ^aOdds ratio was based on 10 point increase in APS score; ^bSouth Carolina and New Jersey were dropped from all models because of very low testing rates; ^cadjusted GEE Model I controls for victim's age, sex, race/ethnicity, marital status, and mental health status; ^dadjusted GEE Model II additionally controls for state proportions of male, age ≥ 21, racial and ethnic composition, college degree or above, household income, unemployment, police rate per capita, degree of urbanization, and religiosity; ^eadjusted GEE Model III further controls for year; ^fadjusted GEE Model IV further controls for BAC testing rate by state-year.

*ORs and 95% CIs are significant at $\alpha = .05$.

each homicide victim, NVDRS does not include such information apart from the BAC level among decedents. To test for mediation we used the four-step approach described by Baron and Kenny (1986). We then used the Sobel test for mediation to formally examine whether the attenuation in association between APS score and alcohol-involved homicide (when per capita alcohol consumption added to the model) was statistically significant.

All analyses were conducted using SAS Version 9.3 (SAS Institute Inc., Cary, NC).

Analytic sample

A total of 17 states participated in the NVDRS during the study period, including seven states from 2003 to 2012 (Alaska, Maryland, Massachusetts, New Jersey, Oregon, South Carolina, Virginia), six states from 2004 to 2013 (Colorado, Georgia, North Carolina, Oklahoma, Rhode Island, Wisconsin), three states from 2005 to 2013 (Kentucky, New Mexico, Utah), and one state from 2011 to 2012 (Ohio). This accounted for a total of 150 state-year strata, which included a total of 41,587 homicide victims. BAC data were taken from toxicology reports of victims and were measured as milligrams per deciliter divided by 1,000. Among all homicide victims, 26,974 victims were tested for BAC (65% of all homicide victims across all state-years), which was the sample used for Table 1.

There is a potential bias among state-years with low rates of BAC testing, because in such cases BAC testing might

be more common when alcohol involvement was suspected or clearly evident. We confirmed that, although there was no significant correlation between APS scores and BAC testing by state-year, BAC testing rates were inversely correlated with alcohol involvement among homicide victims. Therefore, in our GEE models (presented in Tables 2 and 3), we excluded data from South Carolina and New Jersey, which had very low BAC testing rates (<30% for all years), and which were also outliers in terms of having high rates of alcohol involvement in homicides with BAC testing. Because there was still a negative correlation between BAC testing rates and alcohol involvement in homicide victimization, our final analytic models for Tables 2 and 3 also controlled for state-year BAC testing rates. Therefore, our final analytic sample for analyses in Tables 2 and 3 included 15 states, 130 state-years of data, and 25,616 homicide victims (76% of all homicides victims in those state-years with BAC testing).

Results

Associations between APS scores and alcohol-involved homicides

During the study period, average APS scores varied across the 17 states (Table 1). Utah and Oklahoma had the highest mean scores (66.1 and 60.9, respectively), and Maryland and Wisconsin had the lowest mean scores (33.7 and 31.7, respectively) (Table 1). In general, there

TABLE 3. Adjusted odds ratios (AORs)^a of alcohol involvement in homicide victimization associated with a 10 percentage point increase in Alcohol Policy Scale (APS) score, stratified by demographic and contextual homicide characteristics, National Violent Death Reporting System, 2003–2012

Demographic/contextual characteristic (no. of victims with BAC testing)	GEE Model IV ^b	
	BAC > 0.00% AOR [95% CI]	BAC ≥ 0.08% AOR [95% CI]
Gender		
Men (19,995)	0.89 [0.80, 0.98]*	0.93 [0.83, 1.04]
Women (5,620)	0.85 [0.72, 0.99]*	0.74 [0.63, 0.88]*
Age, in years		
<21 (4,986)	0.96 [0.80, 1.15]	1.02 [0.80, 1.29]
21–29 (7,615)	0.75 [0.64, 0.87]*	0.83 [0.72, 0.95]*
30–39 (5,183)	0.90 [0.74, 1.09]	0.88 [0.69, 1.10]
40–49 (3,877)	0.92 [0.80, 1.06]	1.05 [0.87, 1.27]
≥50 (3,948)	0.96 [0.81, 1.13]	0.93 [0.74, 1.16]
Race/ethnicity		
White, non-Hispanic (7,954)	0.99 [0.86, 1.12]	0.95 [0.81, 1.11]
Black, non-Hispanic (12,955)	0.86 [0.74, 1.01]	1.06 [0.86, 1.30]
Hispanic (3,040)	0.66 [0.54, 0.82]*	0.65 [0.53, 0.79]*
American Indian/Alaska Native (561)	0.74 [0.29, 1.87]	0.53 [0.20, 1.38]
Other (1,106)	0.74 [0.55, 0.99]*	0.75 [0.55, 1.02]
Veteran		
Yes (1,738)	0.99 [0.76, 1.32]	0.99 [0.72, 1.38]
No (21,730)	0.90 [0.80, 1.00]	0.89 [0.79, 1.01]
Unknown (2,148)	dnc ^c	dnc ^c
Marital status		
Married/civil union (5,135)	0.91 [0.77, 1.06]	0.96 [0.80, 1.16]
Unmarried ^d (20,222)	0.88 [0.80, 0.98]*	0.89 [0.80, 0.99]*
Metropolitan status		
Yes (20,979)	0.86 [0.77, 0.97]*	0.93 [0.82, 1.05]
No (4,476)	0.91 [0.74, 1.11]	0.77 [0.61, 0.97]*
Mental health problem		
Yes (284)	dnc ^c	dnc ^c
No (25,332)	0.89 [0.81, 0.98]*	0.91 [0.82, 1.01]
Substance abuse problem		
Yes (720)	dnc ^c	dnc ^c
No (24,896)	0.89 [0.81, 0.98]*	0.91 [0.81, 1.01]
Firearm involvement		
Yes (17,204)	0.88 [0.78, 0.99]*	0.87 [0.77, 0.98]*
No (8,336)	0.86 [0.76, 0.97]*	0.95 [0.80, 1.13]
Intimate partner violence–related		
Yes (4,107)	0.77 [0.64, 0.93]*	0.82 [0.68, 0.99]*
No (21,509)	0.91 [0.82, 1.01]	0.93 [0.82, 1.05]

Notes: No. = number; GEE = generalized estimating equations; BAC = blood alcohol concentration; CI = confidence interval. ^aAOR was based on 10 point increase of APS score; ^badjusted GEE Model IV controls for decedent's age, sex, marital status, mental health status, state proportions of male, age ≥ 21, racial and ethnic composition, college degree or above, unemployment, median family income, police rate per capita, degree of urbanization, religiosity, year, and BAC testing rate. South Carolina and New Jersey were removed from analysis for all years because of low BAC testing rates (<30% all years) and high rates of alcohol involvement; ^cdnc indicates that models did not converge because of sample size limitations; therefore, no results were available to report; ^dseparated, divorced, widowed, single.

*ORs and 95% CIs are significant at $\alpha = .05$.

were larger between-state differences in mean APS scores compared with within-state changes of APS scores during the study period (as reflected by state means for the study period in comparison with minimum and maximum APS scores within states). Overall, among the 26,974 homicide victims, 38.5% had a BAC greater than 0.00%, including 24.4% of victims with a BAC of 0.08% or higher. States with higher average APS scores (indicative of more restrictive alcohol policy environments) during the study period had a nonsignificantly lower prevalence of alcohol-related homicides ($r = -.20, p = .43$).

After we excluded data from South Carolina and New Jersey because they had BAC testing rates of less than 30% across all years, in adjusted analyses controlling for individual- and state-level covariates and year (Model III), a 10 percentage point increase in APS score was associated with reduced odds of a homicide victim having a BAC greater than 0.00% (AOR = 0.84, 95% CI [0.76, 0.92]) or a BAC greater than or equal to 0.08% (AOR = 0.87, 95% CI [0.79, 0.97]) (Table 2). In the fully adjusted model (Model IV) that also controlled for BAC testing rate, a 10 percentage point increase in APS score was associated with reduced odds of

having a BAC greater than 0.00% among all homicide victims (AOR = 0.89, 95% CI [0.82, 0.99]), among men (AOR = 0.89, 95% CI [0.80, 0.98]), and among women (AOR = 0.85, 95% CI [0.72, 0.99]). For the BAC greater than or equal to 0.08% outcome in fully adjusted models, a 10 percentage point increase in APS score was associated with reduced odds of having a BAC of 0.08% or higher among all women (AOR = 0.74, 95% CI [0.63, 0.88]) but was nonsignificant for all victims (AOR = 0.91, 95% CI [0.82, 1.02]) and men (AOR = 0.93, 95% CI [0.83, 1.04]).

Based on the fully adjusted model (Model IV) presented in Table 2, we conducted a sensitivity analysis in which we excluded all state-years with BAC testing of less than or equal to 60%, and another sensitivity analysis in which we used no lag (rather than a 1-year lag) between APS scores and homicide outcomes; the findings were similar to those in Table 2. In an additional analysis restricted to victims with a BAC greater than 0.00% (i.e., rather than all homicide victims), there was not a significant relationship between APS scores and BAC levels measured as a continuous variable. We also tested whether state-level per capita alcohol consumption mediated the relationship between alcohol policy environment and alcohol involvement among homicide victims. The correlation between per capita alcohol consumption and APS score was moderate-negative ($r = -.47$), but the test of mediation was not statistically significant.

Associations between APS scores and the odds of alcohol-involvement among homicide strata

Among various strata of homicide victims (Table 3), in fully adjusted models a 10 percentage point increase in the APS score was associated with significantly decreased odds of alcohol-involved homicide victimization (i.e., at both the BAC > 0.00% and BAC $\geq$ 0.08% levels) among those who were women, ages 21–29 years, Hispanic, unmarried, victims of firearm homicides, and victims of homicides related to intimate partner violence (Table 3). For strata with nonsignificant findings, point estimates were generally similar, but relatively smaller sample sizes resulted in wider confidence intervals that were greater than unity.

Discussion

To our knowledge, this is the first study to examine the associations between the alcohol policy “environment” (i.e., based on the presence, relative effectiveness, and implementation of multiple policies) and alcohol-related homicide victimization. In fully adjusted analyses, a 10 percentage point increase in APS score (representing more restrictive policy environments) was associated with approximately an 11% decrease in the odds of any alcohol involvement (BAC > 0.00%) among homicide victims. In addition, more restrictive

policy environments were associated with decreased odds of any alcohol involvement among subgroups that were at high risk for homicide or that accounted for a large proportion of homicides, including men, younger adults ages 21–29 years, Hispanics, and victims of intimate partner violence-related homicides. At both BAC levels, there was also a protective association for firearm homicides, which are the most common means of homicide. Because a substantial proportion of homicides involve alcohol, and because policies appear to be protective for alcohol-involved homicide victimization among groups at high risk for homicide, alcohol policies are a promising strategy for homicide prevention (Naimi et al., 2016).

Our study of the policy environment provides further evidence of the associations between more restrictive alcohol policies and lower levels of alcohol-involved homicide victimization and builds on previous research demonstrating that specific alcohol policies prevent violent deaths (Jennings et al., 2014; Scribner et al., 1999).

Although the findings from this study are consistent with those from studies of individual policies, the study is subject to several caveats and limitations. These findings are largely associative in nature. Despite controlling for year in GEE models and using a 1-year lag between prevalent policies and homicide outcomes, we cannot exclude reverse causality as a contributor to the observed association (i.e., the possibility that higher rates of alcohol involvement in homicides could cause states to adopt additional or more effective alcohol policies). In addition, homicide is a multifactorial outcome, and there may be potential unmeasured state- or individual-level confounding factors that could have affected the observed relationships between alcohol policies and alcohol involvement in homicide victimization.

The policy environment measure is based on state-level policies and does not include county or local alcohol policies. However, most alcohol policies within states are promulgated at the state level. Efficacy ratings and implementation ratings assigned to each policy may have been scored differently by a different set of policy experts. Nevertheless, our APS has construct validity to assess the relationships between alcohol policies and binge drinking (Naimi et al., 2014).

Furthermore, our results are plausible because alcohol consumption in general, and binge drinking in particular, have a well-established relationship with violence and victimization (Naimi et al., 2014). Last, analytic models assume that comparable state-year APS scores have similar effects across states and over time. However, it is possible that the inconsistent number of years of data contributed by particular states during the study period (i.e., not all states contributed the same number of years of data) may have biased the study in unknown ways.

NVDRS data also have limitations. Although this study included states from all U.S. census regions, homicide data

were limited to 17 states. Therefore, our findings may not be generalizable to the entire U.S. population. In addition, underreporting of BAC data and incomplete testing for BAC are potential sources of bias because of selective testing. To address this, we eliminated data from two states with very low levels of BAC testing and high proportions of alcohol involvement in homicides and also controlled for state-year BAC testing rates in adjusted models.

Although the NVDRS is a unique data set because it aggregates information from death certificates, law enforcement, coroners, and medical examiner data, there is a possibility that some homicides are misclassified. It is also possible that there are systematic state-specific differences in the timing of BAC testing among those who do not die shortly after their fatal injury (in such cases, BAC levels will decline relative to those at the moment of injury, unless the victim were to continue drinking). Finally, the NVDRS contains only data pertaining to victims of homicide and does not include information about perpetrators. However, alcohol use is a risk factor for victimization as well as perpetration, and previous studies have found comparable rates of alcohol involvement among perpetrators and victims (Darke, 2010).

Future studies should analyze the independent relationships between individual policies within the context of the larger alcohol policy environment. Additional research could also investigate the relationship between policy subgroups (i.e., policies targeting binge drinking among the general population, policies targeting drinking among youth) and alcohol-involved homicide victimization rates in those populations. Similarly, the findings that the alcohol policy environment may differentially affect specific subgroups such as young adults and those of Hispanic ethnicity are important areas for future inquiry. Overall, the findings from our study underscore the importance of the alcohol policy environment as a predictor of alcohol-involved homicide victimization.

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