

Association of State Alcohol Policies With Alcohol-Related Motor Vehicle Crash Fatalities Among US Adults

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 Invited Commentary

IMPORTANCE Motor vehicle crashes are a leading cause of mortality. However, the association between the restrictiveness of the alcohol policy environment (ie, based on multiple existing policies) and alcohol-related crash fatalities has not been characterized previously to date.

OBJECTIVE To examine the association between the restrictiveness of state alcohol policy environments and the likelihood of alcohol involvement among those dying in motor vehicle crashes in the United States.

DESIGN, SETTING, AND PARTICIPANTS This investigation was a repeated cross-sectional study in which state alcohol policies (operationalized by the Alcohol Policy Scale [APS]) from 1999 to 2014 were related to motor vehicle crash fatalities from 2000 to 2015 using data from the Fatality Analysis Reporting System (1-year lag). Alternating logistic regression models and generalized estimating equations were used to account for clustering of multiple deaths within a crash and of multiple crashes occurring within states. The study also examined independent associations of mutually exclusive subgroups of policies, including consumption-oriented policies vs driving-oriented policies. The study setting was the 50 US states. Participants were 505 614 decedents aged at least 21 years from motor vehicle crashes from 2000 to 2015.

MAIN OUTCOMES AND MEASURES Odds that a crash fatality was alcohol related (fatality stemmed from a crash in which ≥ 1 driver had a blood alcohol concentration [BAC] $\geq 0.08\%$).

RESULTS From 2000 to 2015, there were 505 614 adult motor vehicle crash fatalities in the United States, of which 178 795 (35.4%) were alcohol related. Each 10–percentage point increase in the APS score (corresponding to more restrictive state policies) was associated with reduced individual-level odds of alcohol involvement in a crash fatality (adjusted odds ratio [aOR], 0.90; 95% CI, 0.89–0.91); results were consistent among most demographic and crash-type strata. More restrictive policies also had protective associations with alcohol involvement among crash fatalities associated with BACs from greater than 0.00% to less than 0.08%. After accounting for driving-oriented policies, consumption-oriented policies were independently protective for alcohol-related crash fatalities (aOR, 0.97; 95% CI, 0.96–0.98 based on a 10–percentage point increased APS score).

CONCLUSIONS AND RELEVANCE Strengthening alcohol policies, including those that do not specifically target impaired driving, could reduce alcohol-related crash fatalities. Policies may also protect against crash fatalities involving BAC levels below the current legal limit for driving in the United States.

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Motor vehicle crash fatalities are a leading cause of injury death in the United States. Of the 33 736 motor vehicle crash fatalities in 2014, approximately 30% were alcohol related, meaning that they resulted from crashes in which one or more drivers had a blood alcohol concentration (BAC) at the legal limit of 0.08% or higher.^{1,2} While the number of motor vehicle crash fatalities and alcohol-related motor vehicle crash fatalities has declined, the proportion of crash fatalities that are alcohol related remains high and stable over time.³⁻⁵

Individual alcohol control policies (eg, BAC 0.08% per se laws for driving, referred to subsequently as 0.08% BAC laws) can reduce alcohol-related crashes and deaths.⁶⁻¹⁰ According to the Centers for Disease Control and Prevention Community Guide, effective policies to counter impaired driving include lower BAC laws for young or inexperienced drivers (ie, zero tolerance laws), 0.08% BAC laws for adults, ignition interlocks for individuals convicted of alcohol-impaired driving, and sobriety checkpoints.^{11,12} The Community Guide also recommends minimum legal drinking age laws and dram shop liability laws as effective drinking-oriented policies that effectively reduce alcohol-related crash fatalities.^{11,12}

In the United States, alcohol policies and policies targeting impaired driving vary considerably between states. While driving-specific policies are important, our research team has shown that more restrictive consumption-oriented policies are independently protective for self-reported alcohol-impaired driving among US adults.¹³ In addition, some consumption-oriented policies, such as higher taxes and minimum legal drinking age laws, are protective for alcohol-related motor vehicle crashes.¹⁴⁻¹⁶ Alcohol-related motor vehicle crashes are likely associated with multiple policies targeting both excessive drinking and impaired driving.^{11,17} To our knowledge, no prior study has analyzed the association between the overall alcohol policy environment and alcohol-related crash fatalities. In addition, the independent associations of policies designed to reduce excessive drinking (ie, drinking-oriented policies) vs those designed to prevent driving after someone is already impaired (ie, driving-oriented policies) are unknown.^{13,18}

We hypothesized that stronger (ie, more restrictive) alcohol policy environments would be associated with lower odds of alcohol involvement in motor vehicle crash fatalities and that the subgroup of drinking-oriented policies would have independent protective associations. The objectives of this study were to analyze the association between the alcohol policy environment and alcohol involvement in crash fatalities among adults of legal drinking age (ie, individuals aged ≥ 21 years) and to examine whether 2 policy subgroups—drinking-oriented policies and driving-oriented policies—are independently associated with alcohol-related crash fatalities among adults.

Methods

Measuring the Alcohol Policy Environment

To measure the alcohol policy environment, our research team developed the Alcohol Policy Scale (APS), which assesses the de-

Key Points

Question Are alcohol-related motor vehicle crash fatalities less likely in states with more restrictive alcohol policy environments?

Findings This repeated cross-sectional study examined the association between an aggregate measure of state alcohol policies and 505 614 adult motor vehicle crash fatalities in the United States from 2000 to 2015. A 10-percentage point increase in the restrictiveness of the state alcohol policy environment was associated with a 10% reduced odds that a crash fatality was alcohol related; policies were similarly protective for alcohol involvement at blood alcohol levels below 0.08% (the current legal limit in the United States).

Meaning Strengthening alcohol policies could reduce alcohol-related crash fatalities.

gree of implementation and the efficacy of 29 alcohol policies from 1999 to 2014 in all 50 states and Washington, DC.^{6,19} Several methods of policy aggregation and weighting were assessed, and we chose the measure based on its ability to explain state-level variance in drinking outcomes (according to best goodness of fit using R^2 values); we subsequently assessed its association with our outcomes of interest (eg, impaired driving among adults).¹³ Briefly, a panel of 10 experts from multiple disciplines, including law, public health, economics, sociology, and psychology, nominated and selected policies for inclusion and developed the relative efficacy and implementation ratings for each policy using a modified Delphi approach. Policy data were obtained using the Alcohol Policy Information System (APIS)²⁰ from the National Institute on Alcohol Abuse and Alcoholism (NIAAA), as well as from 18 additional data sources.¹⁹ Examples of alcohol policies that were included in the final APS score were alcohol taxes and characteristics of 0.08% BAC laws. Panelists used their expertise and the available scientific literature to independently rank alcohol policies in terms of their efficacy in reducing excessive drinking and/or alcohol-impaired driving. “Implementation ratings” were determined by specifically examining the provisions that made alcohol policies applicable, effective, or enforceable in terms of reducing excessive drinking and/or alcohol-related harm.¹⁹ The study was determined to be exempt as human participants research by the Boston Medical Center institutional review board.

The APS scores by state-year were obtained by summing each of the 29 alcohol policies after weighting each present policy by its efficacy rating and implementation rating for that year. The scores were standardized on a scale from 0 to 100; 100 was considered the theoretical maximum APS score. Higher APS scores indicated more restrictive policy environments. In 1999 and 2014, respectively, the mean APS scores were 45.1 and 50.3, the median scores were 47.3 and 50.4, and the ranges were 20.4 to 67.7 and 27.7 to 70.1. Over the study period, the mean absolute (either positive or negative) change in state score was 5.3. In addition to the overall APS score based on 29 policies, alcohol policies were separated into 2 mutually exclusive subgroups consisting of 21 drinking-oriented policies (eg, alcohol taxes and limits on outlet density) and 8 driving-oriented policies (eg, sobriety checkpoints and

characteristics of 0.08% BAC laws). Using analogous methods, we also examined 2 mutually exclusive policy variables according to tax magnitude (based on a 10% difference in state tax per standard drink, or approximately 3 cents) vs the remaining 28 policies.

Motor Vehicle Crash Fatalities

We used 2000 to 2015 crash fatality data from the Fatality Analysis Reporting System (FARS) administered by the National Highway Traffic Safety Administration.²¹ According to FARS, a motor vehicle crash death is defined as involving at least one motor vehicle; resulting in the death of a driver, passenger, cyclist, pedestrian, or occupant of a vehicle not in transit within 30 days of the crash; and occurring on a US public road. FARS encompasses a census of all motor vehicle crashes in all 50 US states annually.

For each state-year, data were extracted for those 21 years or older who died in motor vehicle crashes. Demographic data of decedents included sex, age, and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other). For decedents, fatalities were defined as alcohol related if at least one driver involved in the crash had a BAC of 0.08% or higher (ie, the legal definition of impairment). Subsequent analyses assessed the associations between APS scores and the odds of alcohol involvement at BAC cutoffs less than 0.08% (eg, the odds that ≥ 1 drivers had a BAC $\geq 0.05\%$).

Because BAC levels are not directly measured among all motor vehicle crash decedents, FARS provided 10 imputation sets to address missing BAC levels using a validated multiple imputation technique.²² For each missing BAC, the National Highway Traffic Safety Administration provides 10 probability-based imputed values that are combined into an unbiased estimate and standard error of the BAC using multiple imputation. We applied this technique to the 22.6% of drivers for whom BAC was missing in our sample. By year, the percentage of imputed BAC values was similar across the study period. In crashes with measured BACs, 34.5% of fatalities were alcohol related vs 42.7% being alcohol related in crashes with imputed BACs.

Statistical Analysis

For all analyses involving persons with FARS-imputed BACs, we pooled results across 10 imputation sets to calculate mean coefficient estimate and SE estimate. Generalized estimating equations logistic regression models were used to assess the association between APS scores and the odds that a crash fatality was alcohol related. We calculated odds based on a 10-percentage point difference in policy score, which approximated the interquartile range of policy scores among states during the study period. Generalized estimating equations models were fit using alternating logistic regression models to account for clustering of multiple deaths within a crash and multiple crashes occurring within states.²³ Because there is a delay between policy enactment and implementation, we used a 1-year lag to analyze the data. For example, APS scores from 2010 were related to crash fatality data from 2011.

An additional analysis was conducted to examine whether state per capita alcohol consumption (using data from the US Alcohol Epidemiologic Data Reference Manuals²⁴) mediated the independent association between drinking-oriented policies and the odds that a crash was alcohol related. In theory, the effect of such policies should be largely explained through their influence on consumption patterns in the population. To test for mediation, we used the 4-step method described by Baron and Kenny²⁵ and used the Sobel test to examine whether the observed attenuation was statistically significant.

In adjusted analyses, individual-level covariates included age, sex, race/ethnicity, and year. State-level covariates included the proportion of men, race/ethnicity proportions, proportion of the population aged at least 21 years, level of urbanization, median household income, proportion of individuals with a college education, state policing rates, and the mean number of vehicle miles traveled per person. All state-level covariates were extracted from the US Census Bureau's American Community Survey and Current Population Survey²⁶ with the exception of vehicle miles traveled, which were obtained from the Federal Highway Administration.²⁷

We also performed similar stratified analyses among drivers vs passengers and on the basis of demographic and crash-related factors (eg, day of the week and time of day). All analyses were conducted using statistical software (SAS, version 9.4; SAS Institute Inc). All *P* values were 2-sided and considered significant at *P* < .05.

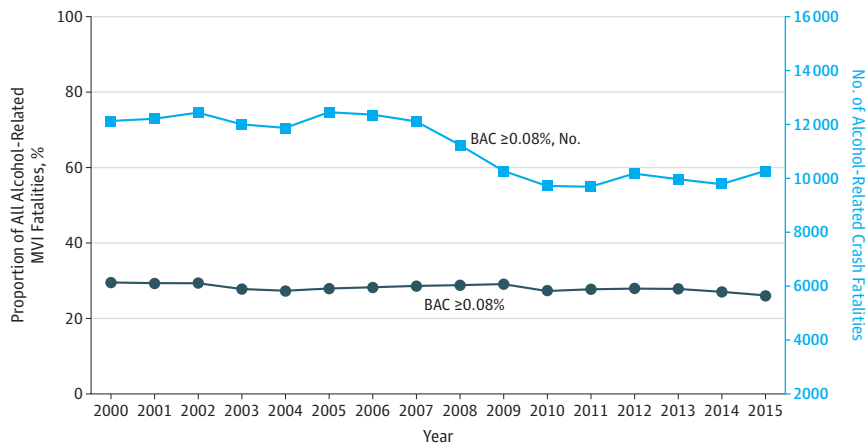
Results

In this repeated cross-sectional study, 505 614 adult motor vehicle crash fatalities in the United States from 2000 to 2015 were examined, of which 178 795 (35.4%) were alcohol related. During the study period, the number of alcohol-related crash fatalities declined somewhat, but the proportion of fatalities that were alcohol related was stable (**Figure 1** and **Table 1**). Of alcohol-related crash fatalities, 119 078 (66.6%) were drivers, 26 897 (15.0%) were passengers, and the remainder were pedestrians, cyclists, or occupants of motor vehicles not in transit (**Table 1**). Men (80.1%), young and middle-aged adults aged 21 to 54 years (85.9%), and non-Hispanic white individuals (54.8%) accounted for the largest proportions of all alcohol-related motor vehicle crash deaths.

Most crash fatalities stemmed from single-vehicle crashes (71.5%) and occurred between 6 PM and 5:59 AM (81.3%) (**Table 1**). When stratified by day of the week and time of day, 57.0% of crashes occurred during the 60 hours between 6 PM Friday evening and 5:59 AM Monday morning (**Figure 2**).

In bivariate analysis, a 10-percentage point increase in the APS score, representing a more restrictive policy environment, was associated with reduced individual-level odds of a motor vehicle crash fatality being alcohol related (odds ratio [OR], 0.93; 95% CI, 0.92-0.94). In the fully adjusted model that controlled for all individual-level and state-level covariates and year as a categorical variable (**Table 2**), a 10-percentage point increase in the APS score was associated with reduced odds of a fatality being alcohol related overall (adjusted OR [aOR],

Figure 1. Proportion of Adult Fatalities Associated With Crashes With BAC at or Above the Legal Limit, US Fatality Analysis Reporting System, 2000-2015



BAC indicates blood alcohol concentration; MVI, motor vehicle incident.

Table 1. Characteristics of Adults Who Died in Alcohol-Related Motor Vehicle Crashes, US Fatality Analysis Reporting System, 2000-2015^a

Characteristic	Fatalities, No. (%)			
	All Fatalities (N = 178 795) ^{b,c}	Drivers (n = 119 078) ^c	Passengers (n = 26 897) ^c	Others (n = 32 820) ^c
Sex				
Male	143 134 (80.1)	100 003 (84.0)	16 683 (62.0)	26 448 (80.6)
Female	35 608 (19.9)	19 056 (16.0)	10 205 (37.9)	6347 (19.3)
Age, y				
21-34	78 979 (44.2)	53 901 (45.3)	15 435 (57.4)	9643 (29.4)
35-54	74 616 (41.7)	49 811 (41.8)	8354 (31.1)	16 451 (50.1)
≥55	25 200 (14.1)	15 366 (12.9)	3108 (11.6)	6726 (20.5)
Race/ethnicity				
Non-Hispanic white	97 916 (54.8)	70 571 (59.3)	13 201 (49.1)	14 144 (43.1)
Non-Hispanic black	21 439 (12.0)	12 882 (10.8)	3180 (11.8)	5377 (16.4)
Hispanic	23 960 (13.4)	13 553 (11.4)	4600 (17.1)	5807 (17.7)
Other	35 480 (19.8)	22 072 (18.5)	5916 (22.0)	7492 (22.8)
Census region				
Northeast	20 270 (11.3)	13 452 (11.3)	2883 (10.7)	3935 (12.0)
Midwest	34 727 (19.4)	24 841 (20.9)	5421 (20.2)	4465 (13.6)
South	86 902 (48.6)	58 137 (48.8)	12 658 (47.1)	16 107 (49.1)
West	36 896 (20.6)	22 648 (19.0)	5935 (22.1)	8313 (25.3)
Weekend ^d				
Yes	101 850 (57.0)	66 742 (56.1)	16 897 (62.8)	18 211 (55.5)
No	76 905 (43.0)	52 307 (43.9)	9996 (37.2)	14 602 (44.5)
Time of day				
6:00 AM to 5:59 PM	32 905 (18.7)	24 624 (21.0)	4881 (18.3)	3400 (10.5)
6:00 PM to 5:59 AM	143 325 (81.3)	92 389 (79.0)	21 808 (81.7)	29 128 (89.5)
Vehicles				
Single	127 918 (71.5)	81 359 (68.3)	16 882 (62.8)	29 677 (90.4)
Multiple	50 877 (28.5)	37 719 (31.7)	10 015 (37.2)	3143 (9.6)

^a Alcohol-related motor vehicle crash fatalities were those occurring in crashes in which the blood alcohol concentration of at least one involved driver was 0.08% or higher.

^b Overall category includes not only drivers and passengers but also pedestrians, cyclists, and occupants of motor vehicles not in transit, so the numbers of drivers plus passengers is less than the "all fatalities" total.

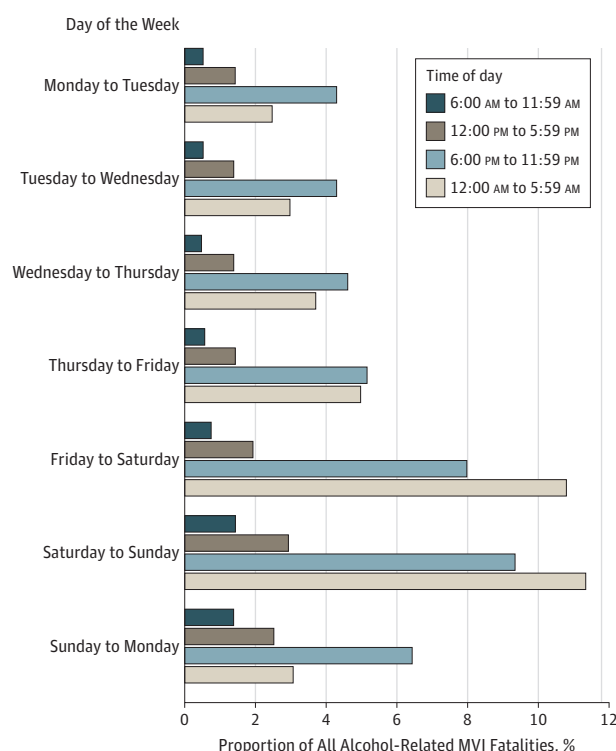
^c Column totals do not match totals for certain characteristics (sex, weekend, and time of day) because of missingness.

^d Weekend days included Friday through Sunday.

0.90; 95% CI, 0.89-0.91), including among drivers (aOR, 0.91; 95% CI, 0.90-0.92) and passengers (aOR, 0.89; 95% CI, 0.87-0.92).

Associations of APS scores with the odds of alcohol involvement among fatalities from various demographic groups

and crash-related circumstances were also assessed (Table 2). Higher APS scores were significantly associated with lower odds that a crash fatality was alcohol related among men and women, all age and racial/ethnic groups, fatalities occurring during weekend and nonweekend days, and fatalities from day-

Figure 2. Proportion of Motor Vehicle Crash Fatalities by Day of the Week and Time of Day, US Fatality Analysis Reporting System, 2000-2015

MVI indicates motor vehicle incident.

time and nighttime crashes. Similar findings were observed for drivers and passengers among these groups but did not have protective associations among non-Hispanic black passengers.

After accounting for the subgroup of drinking-oriented policies, the subgroup of driving-oriented policies was associated with reduced odds of a crash fatality being alcohol related (aOR, 0.94; 95% CI, 0.94-0.95). Similarly, after accounting for the driving-oriented policies, drinking-oriented policies were associated with reduced odds of alcohol-related crash fatalities (aOR, 0.97; 95% CI, 0.96-0.98). Per capita alcohol consumption mediated the association between drinking-oriented policies and the odds that a crash was alcohol related. Tax magnitude was also independently associated with reduced odds that a crash death was alcohol related (aOR, 0.99; 95% CI, 0.99-1.00).

The association between alcohol policies and the odds of alcohol involvement in fatal crashes at BAC levels other than 0.08% were further assessed (Table 3). During the study period, approximately 40% of crash fatalities occurred among crashes in which at least one driver had a BAC of 0.05% or higher, and approximately 60% of crash fatalities occurred in crashes in which at least one driver had a BAC exceeding 0.00%. The association between the stringency of state alcohol policies and the likelihood of alcohol involvement in crash fatalities with BACs from greater than 0.00% to less than 0.08% was similar to those at 0.08% or higher (Table 3). Specifically, more restrictive policy environments were associated with reduced odds of alcohol involvement in crash fatalities associ-

Table 2. Odds That an Adult Motor Vehicle Crash Fatality Was Alcohol Related Associated With a 10-Percentage Point Increase in States' APS Score, US Fatality Analysis Reporting System, 2000-2015^a

Subcategory	aOR (95% CI)			
	All Fatalities ^b	Drivers	Passengers	Others
Full sample	0.90 (0.89-0.91)	0.91 (0.90-0.92)	0.89 (0.87-0.92)	0.91 (0.88-0.94)
Sex				
Male	0.91 (0.90-0.92)	0.92 (0.91-0.93)	0.91 (0.88-0.94)	0.90 (0.87-0.93)
Female	0.89 (0.87-0.91)	0.89 (0.86-0.91)	0.89 (0.86-0.93)	0.93 (0.87-0.99)
Age, y				
21-34	0.89 (0.88-0.91)	0.90 (0.88-0.92)	0.89 (0.86-0.92)	0.87 (0.82-0.93)
35-54	0.90 (0.89-0.92)	0.91 (0.89-0.93)	0.91 (0.87-0.95)	0.91 (0.87-0.95)
≥55	0.92 (0.90-0.94)	0.93 (0.90-0.96)	0.90 (0.84-0.96)	0.92 (0.87-0.98)
Race/ethnicity				
Non-Hispanic white	0.92 (0.90-0.93)	0.92 (0.91-0.93)	0.93 (0.90-0.97)	0.91 (0.87-0.95)
Non-Hispanic black	0.92 (0.89-0.96)	0.92 (0.88-0.97)	0.92 (0.82-1.02)	0.98 (0.89-1.07)
Hispanic	0.85 (0.81-0.89)	0.88 (0.84-0.93)	0.83 (0.76-0.90)	0.82 (0.72-0.94)
Other	0.87 (0.84-0.89)	0.87 (0.84-0.89)	0.87 (0.81-0.93)	0.85 (0.80-0.91)
Weekend ^c				
Yes	0.90 (0.89-0.92)	0.91 (0.89-0.92)	0.92 (0.88-0.96)	0.90 (0.87-0.94)
No	0.91 (0.90-0.93)	0.92 (0.90-0.94)	0.89 (0.86-0.93)	0.93 (0.88-0.98)
Time of day				
6:00 AM to 5:59 PM	0.94 (0.92-0.96)	0.94 (0.92-0.96)	0.95 (0.90-1.00)	0.89 (0.83-0.95)
6:00 PM to 5:59 AM	0.91 (0.89-0.92)	0.91 (0.89-0.93)	0.90 (0.87-0.93)	0.92 (0.88-0.95)
Vehicles				
Single	0.92 (0.90-0.93)	0.92 (0.91-0.94)	0.92 (0.88-0.95)	0.92 (0.89-0.95)
Multiple	0.89 (0.87-0.91)	0.90 (0.88-0.92)	0.89 (0.85-0.93)	0.80 (0.72-0.90)

Abbreviations: aOR, adjusted odd ratio; APS, Alcohol Policy Scale.

^a All models adjusted for age, sex, race/ethnicity, year (as a categorical variable), and state-level covariates (the proportion of men, race/ethnicity proportions, proportion of the population aged at least 21 years, level of urbanization, median household income, proportion of individuals with a college education, state policing rates, and the mean number of vehicle miles traveled per person). Alcohol-related motor vehicle crash fatalities were those occurring in crashes in which the blood alcohol concentration of at least one involved driver was 0.08% or higher.

^b A 1-year lag was introduced between the APS score and crash fatalities (eg, states' mortality rates from 2015 were associated with APS scores from 2014).

^c Weekend days included Friday through Sunday.

Table 3. Alcohol Involvement Associated With a 10-Percentage Point Increase in States' APS Score Among Adults Who Died in Motor Vehicle Crashes, US Fatality Analysis Reporting System, 2000-2015^a

BAC Level Comparison	All Fatalities, aOR (95% CI)
>0.00% vs 0.00%	0.90 (0.89-0.91)
≥0.05% vs <0.05%	0.90 (0.89-0.91)
>0.00% to 0.05% vs 0.00%	0.91 (0.89-0.93)
0.05% to <0.08% vs <0.05%	0.92 (0.89-0.95)
>0.00% to <0.08% vs 0.00%	0.91 (0.88-0.94)

Abbreviations: aOR, adjusted odd ratio; APS, Alcohol Policy Scale; BAC, blood alcohol concentration.

^a All models adjusted for age, sex, race/ethnicity, year (as a categorical variable), and state-level covariates (the proportion of men, race/ethnicity proportions, proportion of the population aged at least 21 years, level of urbanization, median household income, proportion of individuals with a college education, state policing rates, and the mean number of vehicle miles traveled per person).

ated with BACs exceeding 0.00% vs 0.00%, BACs of 0.05% or higher vs less than 0.05%, BACs exceeding 0.00% to 0.05% vs 0.00%, BACs of 0.05% to less than 0.08% vs less than 0.05%, and BACs exceeding 0.00% to less than 0.08% vs 0.00%.

Discussion

To our knowledge, this investigation is the first US study to examine the association between the aggregate alcohol policy environment (ie, as composed of multiple extant policies, weighted by their relative efficacy and degree of state-year implementation) and the likelihood that adult motor vehicle crash fatalities were alcohol related (ie, resulted from a crash in which one or more involved driver had a BAC ≥0.08%) or involved alcohol at lower BAC levels. We found that a 10-percentage point increase in the APS score (which approximates the interquartile range among states) was associated with a 10% reduction in the odds of an alcohol-related fatality (aOR, 0.90). Given the overall percentage of alcohol-related fatalities of 35.4%, this 10% reduction in odds corresponds to lowering the percentage of alcohol-related fatalities to 33.0%, representing a 7% relative reduction in the proportion of alcohol-related fatalities. Assuming that alcohol policies do not affect rates of non-alcohol-involved crashes, this represents approximately 800 fewer crash deaths on a national basis annually, or about 15 fewer crash fatalities annually in an average-sized state. Protective associations were consistent for driver and passenger fatalities and among a variety of decedent and crash strata. The protective association of state alcohol policy environments for adult crash fatalities was of a similar magnitude to that observed for crash fatalities among underage youth younger than 21 years during the same period.¹⁸ However, compared with underage youth, more than 6 times as many of-age adults died from alcohol-related motor vehicle crashes during the study period.

We found that more restrictive consumption-oriented policies (eg, higher alcohol taxes and limits on outlet density) were associated with reduced odds of alcohol-related crash fatalities,

even after accounting for driving-oriented policies. This finding underscores the importance of reducing the economic and physical availability of alcohol to limit frequency and intensity of binge drinking, in addition to the adoption of policies that prevent driving after one is already impaired.^{19,28,29} In a previous study¹³ of the association between state alcohol policy environments and the odds of self-reported alcohol-impaired driving, we also found an independent protective association with drinking-oriented policies. Although many states have adopted stricter drink-driving laws over the past 15 years, the promulgation of effective population-based policies to reduce excessive drinking has been stagnant, and several effective policies, including the magnitude of alcohol excise taxes, have become weaker.³⁰

Similar protective associations were observed for fatalities stemming from alcohol-involved motor vehicle crashes associated with BAC levels below the current 0.08% legal limit for driving while impaired in the United States. Other research demonstrates that the risk of motor vehicle crashes starts to increase at BAC levels above 0.02%, and risks of crash fatalities are substantially elevated at BAC levels of 0.08% compared with a zero BAC.³¹ Reducing permissible BAC levels to 0.05% has been advocated by the US Transportation Research Board and The National Academies of Sciences, Engineering, and Medicine, and a BAC 0.05% limit was recently adopted by the state of Utah, although details of this legislation have yet to be finalized. Most research finds that lowering BACs to 0.05% from higher levels is associated with reduced crash fatalities across all BAC levels.⁸ Unlike the United States, most persons currently living in developed nations are subject to 0.05% BAC driving limits,³² which may explain why the United States has experienced smaller declines in alcohol-related crash fatalities relative to other nations.³³

Limitations

This report is subject to several caveats and limitations. Despite the fact that we included a number of state-level and individual-level covariates, this study may be subject to residual confounding. In addition, our findings are largely associative in nature: despite conducting lagged analyses and controlling for year as fixed effects in our models, our analyses are subject to potential reverse causation. Although our APS has been validated in terms of its ability to explain state-level variance in drinking patterns,^{19,28} others might have used different methods or made different decisions about the development of variables to represent the alcohol policy environment. The APS scores are based on state-level policies and do not incorporate potential influences of federal or local policies. However, most alcohol policies within states are promulgated at the state level, and many states also have preemption laws that limit the nature and scope of permissible local alcohol policies. In cases in which FARS does not obtain BAC testing results, it uses a validated multiple imputation measure.²² However, it is possible that there are state-specific differences in the nature and timing of BAC testing among drivers involved in fatal motor vehicle crashes or that state-level differences in tested vs imputed BAC levels may have affected our results in unknown ways.

Conclusions

Alcohol-related motor vehicle crashes remain an important public health problem and a leading cause of injury-related mortality in the United States and worldwide. Our findings underscore the potential to reduce alcohol-related crash fatalities

by strengthening alcohol policy environments generally, including comprehensive approaches combining policies to reduce drinking to the point of impairment along with those to prevent driving after one is alcohol impaired. These results also support the notion that more restrictive policies may reduce the likelihood of alcohol involvement in crashes at BAC levels below the current legal limit for driving in the United States.

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Author Contributions: Dr Naimi had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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