Robert Wood Johnson Study revealed that Shreveport, B.R. and N.O. are in the top 25 cities nationwide with the greatest number of A/R traffic fatalities.

The Population Consumption Model, Alcohol Control Practices and Alcohol-Related Traffic Fatalities

Running Title: Alcohol Related Traffic Fatalities

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Abstract

Background: More than 40% of urban traffic fatalities are alcohol-related and the rate of such fatalities varies more than ten-fold across US cities. These variations might be explained by differences in local alcohol control policies and practices.

Methods: We conducted a cross-sectional survey of State Alcohol Beverage Control (ABC) agencies and local city police departments in 107 cities that participate in the National Highway and Traffic Safety Administration's Fatality Analysis Reporting System (FARS). We examined the association of alcohol control practices in 1997 and alcohol-related traffic fatalities per daily vehicle miles traveled, 1995-1997.

Results: Ninety-seven (91%) cities participated. Regulations related to alcohol accessibility, licensure of alcohol outlets, disciplinary procedures of alcohol outlets, and enforcement of blood alcohol concentration (BAC) laws were associated with lower rates of fatalities. Cities with 9 or fewer of the 20 regulations had 1.46-fold greater alcohol-related traffic fatality rates than cities with 15 or more of these regulations, representing 392 excess deaths annually. Beer consumption was found to be a potential mediator of the effect of regulations on traffic fatalities.

Conclusions: Alcohol beverage regulations are associated with alcohol-related traffic fatalities. Localities should consider greater restrictions on alcohol accessibility, stricter disciplinary measures for violations and stricter licensure requirements as a potential means to reduce alcohol-related traffic fatalities.

Key Words: Alcohol policy, traffic fatalities, alcohol accessibility

Introduction

Alcohol-related problems are typically viewed as having a genetic basis in which environmental factors contribute to the expression of the underlying disease (1). This represents a medical disease model. People who drink alcohol excessively and suffer negative consequences of alcohol use are believed to be suffering from a disease related to heritable genetic characteristics triggered by environmental or psychological factors (2). Most physicians manage alcoholism by prescribing counseling or other intensive, individualized treatment regimens. Accordingly, if this is the correct management model, the incidence of alcohol-related problems should decrease if alcoholics are matched to the treatment regimen appropriate for their level of disease.

An epidemiological perspective on alcohol use, "the population consumption model" (3), also called the single distribution theory (4-6) has gained a considerable degree of acceptance in explaining alcohol use in populations (7,8). This model states that alcohol consumption by any individual is, in part, a function of the overall distribution of consumption of the community and leads to the conclusion that magnitude of alcohol-related health problems in a population is directly related to per capita consumption (3, 9-11). Individual consumption in turn is associated with various factors affecting the physical and social availability of the product within the community in which individuals reside (12).

In spite of the evidence that community level consumption of alcohol drives alcohol-related morbidity and mortality, control of alcohol-related problems through community interventions has not advanced in the same way control of tobacco has (13,14). While price controls in the form of taxes are likely to be most potent control of alcohol consumption (15-17), taxes on alcohol are less than 1% of all taxes, significantly lower than at the turn of the century when alcohol taxes comprised 40% of all taxes (18). Alcoholic beverages sometimes cost less per ounce than bottled water, orange juice or milk, yet most state and federal legislators have been unwilling to increase taxes on alcohol.

Alcohol-related traffic fatalities accounted for 50,562 deaths nationally during the three years between 1995 and 1997 (19). In general, alcohol-related traffic fatalities have been declining over the past two decades, which can be partly explained by declines in alcohol consumption, enactment of the minimum drinking age on a national level, and widespread adoption of deterrence strategies (20). Specific policies that appear to reduce alcohol-related traffic fatalities include the adoption of laws governing the minimum allowable blood alcohol concentration (BAC) (21), dramshop liability (22,23), server training programs (24), alcohol excise taxes (17, 18), limiting the density of alcohol outlets (25-27), and a variety of individually targeted deterrence practices such as license suspension and sobriety checkpoints (28, 29). However, in a national analysis, Sloan et al found no benefit of mandatory penalties for driving while intoxicated (DWI) (22). In many cases evaluations of alcohol control practices have been limited to only one policy (21, 23, 17, 18, 25), examined interventions that were implemented over a short period of time (21, 28), or were restricted to specific geographic areas (21, 23, 24, 27, 28). Only a handful of national studies have examined a limited number of alcohol control practices and their possible impact on alcohol-related traffic fatalities, and these were at the state level (4, 14-17).

The US Constitution left the states the power to regulate matters related to health, welfare and safety. Thus, significant state and local infrastructures have been developed over the past 225 years to enforce alcohol control laws and regulate alcohol outlets. Because cities usually have the ability to enact even more stringent measures than the state, there are significant differences at the local level in how alcohol is regulated across the United States. Not only do laws, licensing policies, and taxes vary, but so does enforcement of laws that might otherwise be similar among cities. Indeed, there is a 12-fold variation in the rate of alcohol-related fatalities per capita between the largest US cities (19). Considering that alcohol-related fatality rates differ across cities with similar alcohol taxes (Table 1), other regulatory practices are likely to protect against alcohol-related crashes, while at the same time remain politically acceptable to the American public. Such regulations would aim to control the time and place of alcohol consumption (Figure 1).

In order to identify protective alcohol beverage control strategies that appear to be effective across the United States, we conducted a national study of the agencies that are charged with the enforcement of alcohol beverage laws. While other studies have examined differences in state level practices, our approach is unique in that our focus was on regulations and agency enforcement practices at the city level. We examined the association between regulatory policies and the incidence of alcohol-related traffic fatalities.

Methods

In 1998 questionnaires with items that covered six regulatory domains were sent to all city offices of the State Alcohol Beverage Control (ABC) Agencies and to the local city police departments in all 107 cities with populations over 150,000 that participate in the National Highway and Traffic Safety Administration's Fatality Analysis Reporting System (FARS) (19). The questions referred to actual practices in these domains in the calendar year 1997.

The 107 cities represented 38 states. Some states had only one city represented, but others had as many as 15 (California), or 10 (Texas). The next highest were five from Ohio, and six in Florida. Questions asked of the State ABC Boards were nearly identical to those asked of the local police; however we asked them to provide additional information for licensing of alcohol beverage outlets (ABO's), penalties to owners of ABO's, density limits, restrictions on alcohol sales, and server training.

The seven domains we studied include 1) laws governing accessibility of alcohol (34-36); 2) licensure requirements for alcohol outlets; 3) disciplinary procedures for outlets that violate existing laws; 4) enforcement practices: the type, frequency, quality of enforcement of existing laws and whether these practices had changed in the previous year (37); 5) policies relating to driving under the influence (DUI) 6) resources available to enforcement officers, including rewards, benefits, salaries, training and position on the enforcement hierarchy; and 7) public relations/education undertaken by the regulatory agencies targeted either toward the public or the outlets.

Indices were created for each of five alcohol-control domains to reduce the number of variables while improving the predictive power of the measure. There was so little variability in the latter two domains, that no reliable index could be created. The selection of variables for each group was based on a-priori hypotheses of their importance toward the control of alcohol. All variables were equally weighted by normalizing variables with 3 or more categories and by log-transformation of skewed variables. In addition, variables were coded to reflect the same direction of control, that is, from looser to stricter policies. A reliability analysis was performed for each index (Tables 2 through 6). After analyzing the indices separately, we grouped regulations from the first four indices together and found that removal of items in the enforcement index significantly increased the reliability of a combined scale (Cronbach's alpha= 0.85) (38). We dichotomized each of the measures to reflect any policy implementation versus none (for regulatory practices with ordinal responses) or to reflect above and below the median (for continuous responses) . We then examined the association of the combined scale of 20 regulatory practices and our outcome measure.

Combining ABC and local data. Information collected from both the ABC Boards and the local police departments was combined before creating indices. The accessibility variables were readily combined as they tended to measure well-established laws - such as open containers in vehicles, public drinking laws, and drive through liquor stores. For this reason the agreement between ABC and police was quite good. On the other hand, it was difficult to get complete data on DUI enforcement, as this was often regulated by differing agencies. In some cases state police or Departments of Public Safety were responsible for DUI enforcement, rather than local police of ABC agencies. Combining enforcement variables posed several problems because practices tended to differ between ABC and police; in some cases their duties overlapped. We addressed this by taking the answer that showed the greatest level of enforcement, thus giving the best possible scenario for enforcement. Where only the ABC or the police completed the survey, responses may not accurately reflect enforcement practices for that city. We also inquired as to how enforcement practices had changed since the previous year. We examined the relationship of the direction of change in enforcement with the change in alcohol-related traffic fatalities both together and separately for responses by police and ABC agencies. Discipline and licensure information was only provided by the ABC Agencies. Public awareness activities, routine procedures, and non-alcohol related duties also differed between ABC Boards and police.

The same procedure used to combine enforcement variables was applied here. Resource variables were kept separate since most information was on the qualifications of agents.

Missing data. Like many studies in the social sciences dealing with questionnaire data, missing data is a common problem, which must be handled in a statistically robust manner. In our study, missing data is a particular problem because of the sampling frame. The analysis method used full information maximum likelihood to estimate the regression parameters with all data over partially complete data. These analyses were conducted using the AMOS (Analysis of Moment Structures) technique (39). Although we only present results on the observed data, results were subsequently confirmed, and in most cases the statistical significance of associations were strengthened, on a more complete data-file with analysis of complete and partially complete data using the AMOS procedure.

Outcome measures. We chose the Fatality Analysis Reporting System (FARS) database as a relatively unbiased measure of alcohol-related mortality. The FARS database is collected by the National Highway and Traffic Safety Administration (NHTSA) and documents all traffic fatalities annually including alcohol positive pedestrians and cyclists killed by a sober driver. Fatalities per 100,000 population where the police accident report explicitly states or implies that alcohol was involved were adjusted for the proportion of fatalities with alcohol involvement. The proportion of urban crashes that were alcohol involved between 1995-1997 nationally was greater than 44%. Because the risk of a traffic crash is highly associated with the number of miles driven (40, 41), we divided each city's annual alcohol-related traffic fatalities per 100,000 by its per capita daily vehicle miles traveled for the corresponding year, making our outcome measure alcohol-related traffic fatalities per daily vehicle miles traveled (DVMT)(42). We then averaged the results from 1995 through 1997. Table 1 shows how alcohol-related traffic fatalities vary across cities when adjusted for population, compared to how they vary when adjusted for driver vehicle miles traveled. The correlation between the two measures is high (r=0.84) and most cities have similar relative positions in both rankings.

Additional variables. Other factors known to affect traffic crashes were based upon literature review (21-34, 41, 43) and collected from various sources. It is important to note that some of these were city level, and others state level. The variables of interest were: minimum age for a state drivers license in 1997 (44, 45); vehicle inspection practices (46); percent total city earnings from hotels and lodges in 1997 (tourism) (47); city demographic information including age, (% population over 65 years); gender distribution (% males ages 15-24), race, education (% population over 25 with a high school diploma and % population over 25 with a college degree) and percent of the population in poverty (48). All census data were obtained from the 1990 U.S. Census, with population adjustments to 1995 (48, 49).

Alcohol consumption data were available only at the state level (50). We tested the relationship of total alcohol consumption including wine and beer consumption as a full mediated model, recognizing that the measure of alcohol consumption per capita was calculated based on state-wide consumption, rather than the city.

Analysis. We analyzed data using SPSS (51). Potential confounding factors associated with alcohol-related fatalities were controlled for in a multivariate analysis using backwards elimination, a method in the ordinary least squares regression procedure (52). Separate models using alcohol-related traffic fatalities as the dependent variable were examined for all four indices due to collinearity and sampling problems (See Appendix for correlations). The other independent variables were entered with each index. We also ran the models with and without a state level variable as to whether blood alcohol concentration (BAC) testing is mandatory in traffic fatalities. The presence of mandatory BAC testing did not alter our findings, suggesting a lack of assessment bias. A summary index of protective alcohol related policies was developed after checking for reliability using Cronbach's alpha (38). For each of the indices that were associated with lower rates of alcohol-related traffic fatalities, we dichotomized the regulation as either present or absent, or at the midpoint of its value (e.g. number of things to inform public about a new license application, $\leq$3 vs. $\geq$4). We then calculated the number of excess deaths by comparing the number and rate of deaths in cities with few regulations to the deaths in cities with most of the 20 regulatory practices.

Results

Out of 107 cities surveyed responses were available for 97 (91%). This included responses from 61 local and state agencies serving the same locality, only ABC (n=25), and only local (n=11). By city, the number of alcohol-related traffic fatalities varied between 0.8/100,000 to 10/100,000.

Tables 2-6 describe the characteristics of the accessibility, licensure, discipline, enforcement and DUI indices and their reliabilities. No composite index was identified for the resources available to enforcement agents and for public relations/education. However, the items that we investigated were relatively similar throughout the United States. The average starting salary for an enforcement officer was $27,378, and in 78/97 (80%) of cities new agents earn $\leq$$30,000 per year. New Jersey was an outlier, paying $65,000 because officers have to attain the level of detective before working in the alcohol unit. Salary alone was related to traffic fatalities, but it appeared to be only a proxy for socioeconomic status as the relationship disappeared once it was adjusted for per capita income. There were no significant differences between ABC agents and police officers in the length of stay in the job, even though 47% of State ABC agencies claimed benefits for state agents were worse than for the local police. Public relations efforts were minimal throughout the country and no office had a dedicated annual budget for this. Sixty three percent of states had a dedicated public information officer, but funds for public information and materials were available only on a limited basis. Public information campaigns were usually paid for by other departments or programs or were not under the alcohol enforcement agency infrastructure. No items in these two domains were correlated with alcohol-related traffic fatalities.

The accessibility index includes measures of how difficult it is to obtain alcohol. Of note is that among the 89 cities for which data are available, the number of alcohol outlets per 100,000 population varied between 77 and 1,533. Eighty-five percent of cities prohibited public drinking, 70% prohibited anyone from drinking in a car, and 62% prohibited drive through alcohol outlets. Only 31% required keg registration. Twenty-five percent had no food service laws associated with on-premise alcohol sales, 64% had no restrictions about alcohol consumption at sports events, and 73% allowed youth under 21 to enter bars. Cities with more restrictions on the accessibility of alcohol had significantly lower traffic fatalities ($r = -0.331$; $p < .002$). (See Table 2.)

All states require businesses that sell alcohol to have a state license. The licensure index contains items that are requirements of, or restrictions on alcohol licenses. The average initial cost of an alcohol license in a restaurant serving alcohol was $3,702 and varied from $30 to $20,000. Few cities had limits on beer and wine outlet alcohol licenses; 49% restricted the number of outlets selling hard liquor. More than half the cities did at least 3 different things to inform the public prior to approving alcohol licenses, while 10% of cities had no mechanism to inform the public at all. The stricter the license requirement, the lower the alcohol-related traffic fatalities ($r=0.293$, $p< .012$). (See Table 3.)

The discipline index focused on serious penalties that outlets could receive if convicted of a violation, including fines and suspension of their license to sell alcohol. Forty-five percent of cities said they never waived second penalties, 50% rarely waived penalties, and 5% of cities reported that they sometimes did. The more definite and serious the penalty, the lower the traffic fatalities in the city ($r= -0.379$ $p < .000$). (See Table 4.)

When examining the scope of enforcement it was clear that many jurisdictions do not monitor compliance with alcohol beverage laws on a routine basis. Twelve cities had no dedicated alcohol enforcement agents. Among those that did, the average number of outlets per enforcement agent was 296, and varied from 1.5 to 1,638. Nationally, of the 114,837 outlets for which enforcement information is available from this survey, 20% are never monitored with underage compliance checks. An additional 32% were from cities where less than 5% of all outlets were visited in 1997. The enforcement index was positively correlated with alcohol-related fatalities ($r= .284$ $p<.008$), indicating a greater number of traffic fatalities in cities whose enforcement practices are stricter ($p=0.021$, Table 5). When we analyzed the item asking how enforcement practices had changed from the year prior to 1997, 43/76 (56.6%) state ABC agencies had increased their enforcement efforts. Between 1995 and 1996, 27/76 (36%) cities had experienced an increase in alcohol-related traffic fatalities of more than a 0.5 standard deviation. Of these 27 cities, 20 (74%) subsequently increased their enforcement efforts in 1997 compared to 7/27 (26%) that did not increase enforcement efforts [RR 3.23 (95% CI 1.04, 10.31; $p < .02$)].

The DUI index captured the state legal limit for BAC, frequency of sobriety checkpoint and whether these were random or non-random. The index was negatively correlated with alcohol-related fatality rates. Among states with a BAC < .08, 68% set up random checkpoints and only 3% had no checkpoints. In contrast, 49% of cities with BAC at .10 did not set up checkpoints, and only 21% did random checks.

Alcohol taxes, including beer taxes, were not associated with alcohol fatality rates in our sample. In a multivariate model using backwards regression controlling for the minimum age for a driver's license, the percentage of households in poverty, vehicle inspection practices, % population over 65, % population male between the ages of 15-24, % population over 25 with a high school diploma or a college degree, and the level of tourism, alcohol accessibility remained a predictor of traffic related fatalities (p=0.046, See Table 6). In separate models, the licensure and discipline indices were likewise associated with traffic fatalities (p=0.059 and p=0.058, respectively). Total alcohol consumption was not significantly associated with alcohol-related traffic fatalities in any of the multivariate models (not shown). However, when we added beer consumption separately as a mediating variable, the effect of the regulatory indices was reduced, indicating that the beer consumption variable may be mediating the association between regulatory activities and alcohol-related traffic fatalities (Table 7). Wine and spirits consumption, in contrast, did not have any mediating affect on alcohol-related traffic fatalities, separately or together.

The accessibility, licensure, and discipline indices were correlated with each other (r= 0.46-0.56), while enforcement did not correlate with any of the other three (Appendix). The DUI index was correlated with the accessibility index but not with any of the other indices. Cities with 9 or fewer of 20 regulatory practices in a combined index of accessibility, licensure and disciplinary items had 1.46 times the alcohol-related traffic fatality rates than cities with 15 or more of the 20 practices ($p < 0.002$). This represents an estimated 392 excess deaths annually. Similarly, cities with an alcohol fatality rate below -1.00 standard deviation from the normalized mean had an average of 14.2 regulations compared to an average of 8.9 regulations for cities more than one standard deviation above the normalized mean ($p < 0.019$). Figure 2 depicts a linear relationship between the number of fatalities and the number of regulations constraining the context of alcohol consumption ($r = -0.456$).

Discussion

The results indicate that alcohol regulatory practices explain many differences in alcohol-related traffic fatalities across US cities. The items most strongly associated with lower rates of alcohol-related traffic fatalities are those include random sobriety checkpoints and those that influence access to alcohol, such as laws restricting the places where it is acceptable to drink and laws limiting youth access to alcohol. Where outlets are given a certain penalty such as a fine or license suspension (as opposed to only warnings or waivers) for alcohol-related violations, traffic fatalities were also lower.

The finding that beer consumption may mediate alcohol-related traffic fatalities supports the population-consumption model. Beer is the most common type of alcoholic beverage sold (50), and it is widely available cold, in single servings, at convenience stores and gas stations. It is heavily promoted with advertisements that often show people drinking beer in outdoor settings, such as beaches, parks, fairs—all places one would need to drive to in a car. Wine, in contrast, is often portrayed as being consumed with meals, at home, and on special occasions. Spirits are not as heavily advertised and in many cities their access is under state control.

Although the alcohol consumption measure is flawed, as it was measured at the state level rather than the city, one might expect that a city level measure would be more precise and would possibly yield an even stronger mediating effect than the current data indicate (53).

The positive association of enforcement with traffic fatalities was unexpected. Given the increase in enforcement in the majority of cities after they experienced an increase in alcohol-related traffic fatalities, it appears that enforcement is reactive, rather than being regularly applied over time. In this study most cities' agencies reported that their enforcement practices were initiated primarily in response to complaints, rather than implemented on a regular basis. Interviews with enforcement officers revealed that enforcement operations like raids and underage compliance checks vary widely from year to year and may be implemented in response to political concerns or when extra grant funds are available (54). In contrast, the accessibility and licensure indices reflect policies that are more stable over time. Disciplinary practices, however, appear to reflect the political leadership, as the alcohol commissioners are frequently political appointees who may change with every state election. The existence of laws for BAC <.08 was associated with random sobriety check points and is likely to indicate an overall greater local commitment to this aspect of alcohol control.

We think the reason we did not find associations between resources available to alcohol enforcement officers and alcohol-related traffic fatalities, is because there is little variation in this area across the US cities. There are few incentives for aggressive job performance in alcohol enforcement. In contrast to illegal drug enforcement, where a proportion of seizures (including cash and vehicles) becomes the property of the police department, most localities send alcohol-related fines to the general fund of the state.

There is every reason to believe that public education campaigns would increase compliance with alcohol beverage laws, as has been shown with tobacco prevention campaigns (55, 56); however, no localities had any significant budgets to mount any media campaigns.

Limitations

Although we did not receive complete data from all states and cities, using a robust statistical procedure to estimate missing data did not change our results, and, in fact, strengthened their statistical significance. Another limitation is that the data are based upon the self-report of state and city agencies. However, in most cases where we had both state and city level reports, there was good agreement on the accessibility items. The highest disagreement was on enforcement practices, which indicates that that index may not be a good measure of what is actually happening in the field. The indices on DUI and enforcement should be viewed with caution. The DUI data was not as complete, as responses on these practices were received from only 81/97 (84%) cities included in the study. The use of state-level data in the city level models violates the assumption of independence; therefore, the models including state level beer consumption data as a mediator should be viewed with caution. In addition, it is possible that beer consumption is a confounder having an independent effect on alcohol-related traffic fatalities, rather than serving as a mediator. While we have theoretical reasons to suspect beer mediates the relationship (5, 6, 57), our analyses cannot differentiate between confounding and mediation. Longitudinal studies are needed. One final caveat is that our study population data are based upon city residence, while crashes may reflect movement of people to and from suburbs and central cities.

Conclusion

In experimental studies, policies like the drinking age and regulations on blood alcohol concentration have been shown to reduce alcohol-related traffic fatalities. It is likely that other policies regulating alcohol use would have a similar effect. Given the cross-sectional nature of the study, a causal relationship between the policies we have identified as being associated with alcohol related traffic fatalities are not proven, but the relationships we have documented make good common sense. Our study suggests that to reduce alcohol-related traffic fatalities localities should consider greater restrictions on alcohol accessibility, disciplinary measures for alcohol outlets that violate alcohol beverage laws should not be waived, alcohol licensure requirements should be stricter, and BAC regulations <0.8 with random sobriety checkpoints should be implemented. More research is needed to determine the relative contribution of beer versus other alcohol products to alcohol-related fatality rates. If beer is implicated as being disproportionately responsible, then additional efforts to regulate beer should be considered.

Because traffic fatalities are only one outcome of alcohol use, alcohol regulations may have positive impacts on other health related outcomes as well (58), including crime and violence (59, 60), homicide and suicide (61-63), and even sexually transmitted diseases (64). Alcohol was estimated to cost the United States $184.6 billion per year in direct and indirect costs of morbidity, mortality and lost wages and productivity in 1998 (65). This figure is second only to the impact of tobacco and is 1.5 times greater than the cost of illegal drugs to society (66). If states or localities make such changes in their alcohol control practices, then it may be possible to prospectively assess the full scope of alcohol control policy benefits on health.

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Table 1: Alcohol Related Traffic Fatality Rates and Beer Tax by City (sorted by traffic fatality rate, column 1)

CITY	Average alcohol related traffic fatality rates per 100,000[1]	Average alcohol related traffic fatality rates per DVMT[2]	Beer tax in cents per drink (12 oz. glass)
Lincoln, NE	.86	.046	2.15
Syracuse, NY	1.31	.053	1.50
New York, NY	1.67	.111	1.50
Madison, WI	1.74	.083	.60
Fremont, CA	1.87	.084	1.87
Honolulu CDP, HI	2.01	.124	5.06
San Francisco, CA	2.07	.099	1.87
Boston, MA	2.16	.109	1.00
Jersey City, NJ	2.29	.150	1.12
Cincinnati, OH	2.36	.089	1.69
San Jose, CA	2.47	.111	1.87
Indianapolis, IN	2.58	.087	1.08
Spokane, WA	2.63	.135	2.44
Wichita, KS	2.64	.132	1.69
Virginia Beach, VA	2.71	.127	3.35
Aurora, CO	2.72	.128	.75
Minneapolis, MN	2.80	.121	1.39
Columbus, OH	2.91	.110	1.69
Seattle, WA	2.91	.117	2.44
Raleigh, NC	2.91	.091	4.98
Baltimore, MD	2.92	.146	.84
Akron, OH	3.01	.126	1.69
Bakersfield, CA	3.05	.176	1.87
Grand Rapids, MI	3.09	.136	1.91
St. Paul, MN	3.15	.136	1.39
Buffalo, NY	3.18	.173	1.50
Milwaukee, WI	3.18	.130	.60
Stockton, CA	3.20	.177	1.87
Toledo, OH	3.29	.140	1.69
San Diego, CA	3.33	.155	1.87
Richmond, VA	3.41	.130	3.35
St. Petersburg, FL	3.42	.161	4.50
Rochester, NY	3.43	.146	1.50

[1] Averaged for 1995, 1996 and 1997.
[2] Daily vehicle miles traveled.

Miami, FL	3.44	.189	4.50
Fort Wayne, IN	3.45	.170	1.08
Colorado Springs, CO	3.49	.196	.75
Pittsburgh, PA	3.54	.177	.99
Long Beach, CA	3.55	.163	1.87
Modesto, CA	3.55	.202	1.87
Santa Ana, CA	3.56	.164	1.87
Omaha, NE	3.57	.173	2.15
Los Angeles, CA	3.58	.164	1.87
Philadelphia, PA	3.59	.220	.99
Des Moines, IA	3.68	.152	1.78
Lexington-Fayette, KY	3.68	.130	4.69
Tulsa, OK	3.91	.176	3.78
Anaheim, CA	3.93	.181	1.87
Mesa, AZ	3.96	.187	1.50
Chicago, IL	4.00	.208	1.73
Anchorage, AK	4.01	.253	3.28
Newport News, VA	4.03	.190	3.35
Hialeah, FL	4.05	.223	4.50
Louisville, KY	4.21	.145	4.69
Tacoma, WA	4.32	.198	2.44
Sacramento, CA	4.45	.208	1.87
Providence, RI	4.53	.231	.91
Greensboro, NC	4.55	.131	4.98
Oakland, CA	4.55	.217	1.87
Norfolk, VA	4.58	.215	3.35
Cleveland, OH	4.59	.211	1.69
Charlotte, NC	4.62	.175	4.98
Portland, OR	4.79	.226	.79
Orlando, FL	4.84	.184	4.50
Winston-Salem, NC	4.98	.163	4.98
Dayton, OH	4.99	.183	1.69
Arlington, TX	5.06	.154	1.81
Fresno, CA	5.07	.281	1.87
Riverside, CA	5.08	.230	1.87
Huntsville, AL	5.23	.187	9.87
Jacksonville, FL	5.31	.198	4.50
Salt Lake City, UT	5.38	.249	3.32
Little Rock, AK	5.45	.212	2.27
Corpus Christi, TX	5.66	.242	1.81
Birmingham, AL	5.67	.170	9.87
Las Vegas, NV	5.68	.309	.84
Washington, DC	5.91	.254	.84
Mobile, AL	5.92	.227	9.87
El Paso, TX	5.98	.329	1.81
Amarillo, TX	6.17	.242	1.81

Tucson, AZ	6.19	.337	1.50
Lubbock, TX	6.30	.266	1.81
Knoxville, TN	6.30	.201	1.18
Denver, CO	6.32	.296	.75
Montgomery, AL	6.33	.250	9.87
Jackson, MS	6.44	.256	4.00
Baton Rouge, LA	6.52	.282	3.02
Shreveport, LA	6.58	.276	3.02
Columbus, GA	6.62	.318	4.50
Oklahoma City, OK	6.94	.283	3.78
Houston, TX	7.03	.235	1.81
Austin, TX	7.11	.244	1.81
New Orleans, LA	7.15	.523	3.02
Atlanta, GA	7.23	.200	4.50
Fort Worth, TX	7.48	.228	1.81
Memphis, TN	7.54	.335	1.18
San Antonio, TX	7.54	.291	1.81
Tampa, FL	7.55	.356	4.50
Newark, NJ	7.55	.501	1.12
Chattanooga, TN	7.92	.263	1.18
St. Louis, MO	7.92	.279	.56
Phoenix, AZ	8.14	.387	1.50
Detroit, MI	8.22	.359	1.91
Nashville-Davidson, TN	8.47	.251	1.18
Albuquerque, NM	8.62	.330	3.84
Kansas City, MO	10.10	.358	.56
Dallas, TX	10.23	.312	1.81
Mean	4.75	.203	2.64
Range	0.86-10.23	.046-.523	.56-9.87

Pearson correlation (p-value):

Fatalities per 100,000 population & fatalities per DVMT .837 (.000)
Fatalities per 100,000 population & beer tax: .103 (.294)
Fatalities per DVMT & beer tax: -.009 (.930)

Table 2: Description of accessibility index and its component variables

Variable	N	Mean(SD)	Bivariate correlation with traffic fatality rates r (p value)
Accessibility Index (Cronbach's alpha = .6113)	89	2.19 (3.23)	-.331 (.002)
Drive through liquor stores prohibited (0=no 1=yes)	97	.62 (.49)	-.303 (.003)
Keg registration required (0=no 1=yes)	97	. 31 (.46)	-.288 (.004)
Drinking prohibited in public (0=no 1=yes)	97	.85 (.36)	-.276 (.006)
Youth < 21 prohibited in bars (0=no 1=yes)	97	.27 (.45)	-.218 (.032)
Food service laws for outlets (0=no laws 1=restaurant 2=all types)	97	.95 (.68)	-.207 (.042)
Number alcohol restrictions in sports events (0 to 3)	97	.43 (.64)	-.172 (.091)
Drinking prohibited in cars (0=no laws 1=passengers can drink 2=no one can drink)	97	1.61 (.65)	-160 (.117)
Number of outlets per 100,000 population (reverse coded)	89	327 (246)	-.016 (878)

Table 3: Description of licensure index and its component variables

Variable	N	Mean(SD)	Bivariate correlation with traffic fatality rates r (p value)
Licensure Index (Cronbach's alpha = .7407)	73	0.98 (2.52)	-.293 (.012)
Initial cost of a state license for a restaurant	83	$3,702 ($4,828)	-.215 (.051)
Limited number of licenses? (0=no 1=yes)	76	.49 (.50)	-.176 (.129)
Whether both state and local authorities notified in licensure (0=no 1=yes)	84	.48 (.50)	-.156 (.156)
Number things do to inform public before approving license (0 to 6)	84	2.89 (1.83)	-.127 (.249)
Number things do to inspect location before licensing (0 to 3)	84	2.01 (.94)	-.106 (.337)

Table 4: Description of discipline index and its component variables

Variable	N	Mean(SD)	Bivariate correlation with traffic fatality rates r (p value)
Discipline Index (alpha low, variables selected a-priori)	82	0.38 (2.10)	-.379 (.000)
Are violations published? (0=no 1=yes)	84	.38 (.49)	-.346 (.001)
Second penalty negotiable? (1=yes, always 2=yes, sometimes 3=not negotiable)	83	2.36 (.73)	-.234 (.033)
Penalty to outlet for 2nd violation (1=warning 2=fine only 3=fine and/or suspension 4= suspension only 5=revocation)	84	3.06 (.95)	-.197 (.072)
Proportion 2nd penalty reduced (0=none 1=rarely 2=some)	83	.78 (.59)	-.170 (.125)

Table 5: Description of enforcement index and its component variables

	N	Mean(SD)	Bivariate correlation with traffic fatality rates r (p value)
Enforcement Index (Cronbach's alpha = .6083)	87	.32 (4.11)	.284 (.008)
How often are raids done? (1=few per year to never 2=once/week to once/month 3=at least few times/week)	97	1.81 (.83)	.262 (.010)
Number things do to enforce food service laws (0 to 3)	97	1.51 (.98)	.181 (.075)
How often do covert operations? (1=few per year to never 2=once/week to once/month 3=at least few times/week)	96	2.35 (.81)	.151 (.141)
Percent outlets did Cops-in-Shops	96	1.73 (4.20)	.128 (.212)
How often verify compliance with food service laws? (1=never or don't do 2=annually 3=few times/year 4=once to few times/month 5=at least weekly)	97	2.97 (1.35)	.119 (.247)
How often enforce drink specials? (1=few per year to never 2=once/week to once/month 3=at least few times/week)	97	2.04 (.79)	.113 (.269)
Outlets per agent (reverse for index – 0 given maximum)	92	257 (347)	-.079 (.454)
Percent outlets that had underage compliance checks	88	8.90 (12.21)	.048 (.660)

Table 6: Description of DUI index and its component variables

Variable	N	Mean(SD)	Bivariate correlation with traffic fatality rates r (p value)
DUI Index (Cronbach's alpha = .7960)	81	1.48 (1.08)	-.191 (.087)
How often are sobriety checkpoints done? (0=never 1=few times/once per year 2=at least once per month)	81	0.91 (.71)	-.222 (.046)
Whether sobriety checks done in random places (0=none 1=not random 2=random)	81	1.09 (.83)	-.196 (.083)
Legal BAC limit (0=.10 1=.08 or less)	92	0.45 (.50)	-.125 (.235)

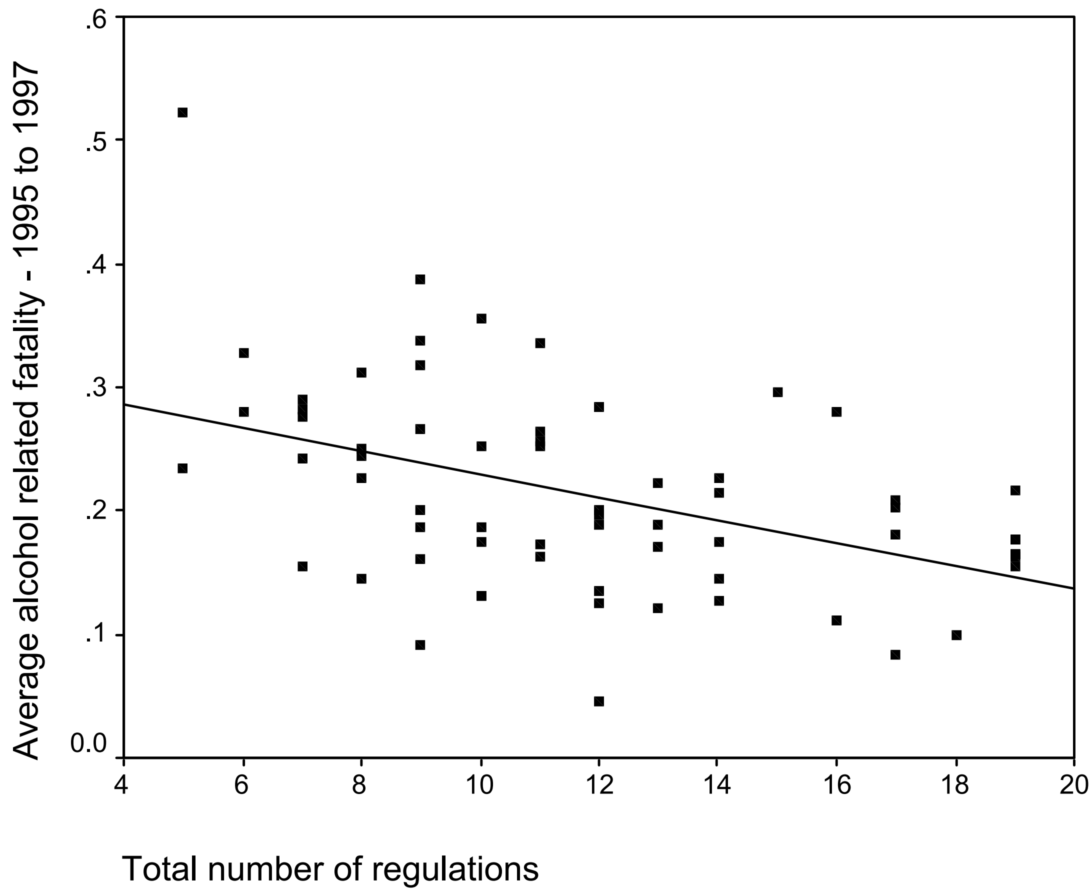
Table 7: Regression coefficients for indices and control variables – alcohol related traffic fatalities per DVMT is dependent variable [Betas (p values)]

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Accessibility index	-.188 (.046)				
Licensure index		-.213 (.059)			
Discipline			-.196 (.058)		
Enforcement index				.210 (.021)	
DUI index					-.279 (.004)
Minimum age for drivers license without education class	-.264 (.006)	-.218 (.055)	-.229 (.020)	-.331 (.000)	-.286 (.003)
Percent below poverty	.388 (.000)	.390 (.000)	.433 (.000)	.391 (.000)	.450 (.000)
Percent all private earnings from hotels and lodges (tourism)	.160 (.080)	.190 (.069)	.121 (.218)	.117 (.194)	.144 (.137)
(constant)	.458	.385	.384	.542	.503
N	87	70	79	86	78
R^2	.378	.355	.398	.403	.390

Table 8: Regression coefficients for indices and control variables with beer consumption added – alcohol related traffic fatalities per DVMT is dependent variable [Betas (p values)]

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Accessibility index	-.027 (.798)				
Licensure index		-.147 (.179)			
Discipline			-.082 (.459)		
Enforcement index				.155 (.078)	
DUI index					-.136 (.231)
Beer Consumption	.304 (.003)	.275 (.009)	.240 (.021)	.264 (.003)	.246 (.035)
Minimum age for drivers license without education class	-.289 (.002)	-.217 (.046)	-.237 (.013)	-.307 (.000)	-.249 (.010)
Percent below poverty	.370 (.000)	.337 (.001)	.399 (.000)	.361 (.000)	.412 (.000)
Percent all private earnings from hotels and lodges (tourism)	.092 (.305)	.144 (.154)	.118 (.214)	.079 (.360)	.087 (.374)
(constant)	.323	.250	.268	.371	.298
N	87	70	79	86	78
R^2	.441	.420	.440	.464	.427

Figure 2: Total number of regulations by alcohol related traffic fatalities per DVMT (r= -.421 p=.000)



Correlation Matrix of Indices – Pearson correlation (p-value) (N).

	Accessibility	**Discipline**	**Licensure**	**Enforcement**
Accessibility	---	---	---	---
Discipline	.561 (.000) (78)	---	---	---
Licensure	.551 (.000) (70)	.457 (.000) (71)	---	---
Enforcement	.074 (.493) (87)	.028 (.808) (78)	.031 (.797) (70)	---
DUI	.315 (.006) (75)	.201 (.106) (66)	.110 (.404) (60)	-.031 (.793) (73)

Precis

This cross-sectional study of 97 cities (91%) indicates that alcohol beverage regulations regarding alcohol accessibility, disciplinary measures for alcohol outlets, requirements for alcohol licenses, and laws enforcing limits on blood alcohol concentration are associated with alcohol-related traffic fatalities.