ORIGINAL ARTICLE

Association between state level drinking and driving countermeasures and self reported alcohol impaired driving

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Objectives: In 1999, alcohol related motor vehicle crashes in the United States claimed 15 786 lives and injured more than 300 000 persons. Drinking and driving behavior is shaped by individual and environmental level influences. In this study, the association between each state's driving under the influence of alcohol (DUI) countermeasures and self reported alcohol impaired driving was explored.
Methods: Mothers Against Drunk Driving's (MADD's) *Rating the States 2000* survey, which graded states on their DUI countermeasures from 1996–99, was used as an index of each state's comprehensive DUI prevention activities. Information on alcohol impaired driving from residents of each state was obtained from the 1997 Behavioral Risk Factor Surveillance System (BRFSS) survey. The association between the MADD state grades and alcohol impaired driving was assessed using multiple logistic regression.
Results: Of the 64 162 BRFSS respondents who reported drinking any alcohol during the past month, 2.1% of women and 5.8% of men reported at least one episode of alcohol impaired driving in the past month. Those living in states with a MADD grade of "D" were 60% more likely to report alcohol impaired driving than those from states with a MADD grade of "A" (odds ratio 1.6, 95% confidence interval 1.3 to 2.1). The association existed for men and women.
Conclusion: These findings suggest that stronger state level DUI countermeasures are associated with lower rates of self reported alcohol impaired driving.

Alcohol impaired driving continues to be an important public health problem in the United States. In 1999, alcohol related motor vehicle crashes claimed 15 786 lives and injured more than 300 000 persons.[1] The prevalence of drinking and driving varies from state to state. A 1993 survey conducted in 49 states and the District of Columbia estimated that the annual rates of self reported drinking and driving episodes varied nearly 10-fold from 165 to 1550 per 1000 population.[2] Efforts to reduce alcohol impaired driving also vary across states.[3–5]

Drinking and driving behavior is shaped not only by individual choice but also by environmental level influences including legal, political, economic, and social factors. Effective prevention, therefore, requires an ecological approach that addresses both the individual level and environmental level influences.[5–9] In this study, we examined the association between a defined set of interventions to reduce driving under the influence of alcohol (DUI), measured at the state level, and individuals' self reported drinking and driving behavior. We hypothesized that residents from states with weaker DUI countermeasures would be more likely to drive while impaired by alcohol.

METHODS

To our knowledge, the most comprehensive source of information about state level DUI countermeasures is Mothers Against Drunk Driving's (MADD's) *Rating the States* survey.[4 10] MADD is a non-profit organization that was founded in 1980. Its mission is to stop drunk driving, support the victims of drunk driving, and prevent underage drinking. MADD developed the *Rating the States* survey in 1991 and has administered an updated version of the survey every few years. The primary purpose of the survey is to bring national attention to the status of each state's comprehensive efforts to reduce DUI.[10] The *Rating the States 2000* survey graded each state and the District of Columbia on their impaired driving and underage drinking prevention activities for 1996–99. The survey methodology is published elsewhere.[4] Briefly, each state received a letter grade of "A+" through "D–" on each of nine categories: presence of DUI laws; trends in percentage of traffic fatalities that were alcohol related; political leadership by the governor and state legislature; completeness and availability of statistics and records; resources devoted to enforcing DUI laws; administrative penalties and criminal sanctions (for example, administrative licenses revocation, mandatory assessment, and treatment for alcohol problems); regulatory control and availability (for example, alcohol server training, eliminating happy hours); youth legislation, prevention and education; and victim compensation and support. In the DUI law category, states were evaluated on two criteria: (1) the total number of key DUI laws implemented out of a possible 32 and (2) the number of key DUI laws that had been enacted since the last *Rating the States* survey in 1996. Twelve of the 32 key DUI laws were given greater weight based on their demonstrated effectiveness in reducing alcohol impaired driving.[4] These laws were administrative license revocation, 0.08% blood alcohol concentration (BAC) limit for adults, primary enforcement safety belt law, illegal *per se* BAC law, graduated driver licensing systems for youth, constitutional amendment for victims rights, mandatory BAC testing of killed drivers, mandatory BAC testing of surviving drivers,

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Abbreviations: CI, confidence interval; BAC, blood alcohol concentration; BRFSS, Behavioral Risk Factor Surveillance System; DUI, driving under the influence of alcohol; MADD, Mothers Against Drunk Driving

Table 1 Estimated percentage of adults aged 18 years or older who consume alcohol who reported alcohol impaired driving, by state, and MADD's *Rating the States 2000* state grades

State	% of BRFSS respondents* (95% CI)	MADD grade†	State	% of BRFSS respondents* (95% CI)	MADD grade†
Alabama	4.2 (2.5 to 5.8)	B–	Montana	4.7 (3.2 to 6.1)	D+
Alaska	3.9 (1.6 to 6.3)	C–	Nebraska	6.5 (4.3 to 8.7)	C+
Arizona	3.5 (1.5 to 5.5)	B–	Nevada	4.9 (2.2 to 7.6)	C–
Arkansas	5.1 (2.9 to 7.4)	B–	New Hampshire	3.1 (1.8 to 4.4)	C–
California	4.1 (3.2 to 5.1)	A	New Jersey	2.6 (1.6 to 3.6)	C
Colorado	4.0 (2.7 to 5.3)	B	New Mexico	3.2 (1.9 to 4.6)	B–
Connecticut	3.3 (2.0 to 4.7)	C–	New York	1.6 (0.9 to 2.3)	B–
Delaware	3.7 (2.1 to 5.3)	B	North Carolina	2.9 (1.8 to 4.1)	A–
District of Columbia	5.8 (3.4 to 8.2)	C–	North Dakota	7.0 (5.3 to 8.7)	D+
Florida	3.4 (2.4 to 4.4)	A–	Ohio	3.1 (1.8 to 4.4)	B–
Georgia	2.4 (1.3 to 3.5)	B	Oklahoma	4.5 (2.2 to 6.8)	B
Hawaii	4.6 (3.2 to 6.1)	B–	Oregon	2.8 (2.0 to 3.6)	B
Idaho	2.7 (1.9 to 3.5)	B–	Pennsylvania	3.5 (2.5 to 4.4)	C
Illinois	5.2 (3.5 to 6.9)	B+	Rhode Island	2.7 (1.7 to 3.8)	C–
Indiana	3.9 (2.7 to 5.1)	B–	South Carolina	2.2 (1.1 to 3.4)	C
Iowa	7.1 (5.8 to 8.4)	B–	South Dakota	6.7 (5.0 to 8.3)	D+
Kansas	6.6 (4.7 to 8.5)	B	Tennessee	3.4 (1.9 to 4.9)	C+
Kentucky	1.7 (0.9 to 2.4)	C+	Texas	8.1 (6.4 to 9.8)	C
Louisiana	6.4 (4.4 to 8.5)	B	Utah	3.0 (1.6 to 4.4)	A–
Maine	1.5 (0.8 to 2.3)	C	Vermont	4.9 (3.1 to 6.8)	C+
Maryland	2.1 (1.2 to 3.0)	B–	Virginia	4.3 (3.1 to 5.6)	B+
Massachusetts	2.7 (1.7 to 3.8)	C–	Washington	2.8 (2.1 to 3.6)	B
Michigan	6.1 (4.7 to 7.4)	B	West Virginia	2.7 (1.5 to 4.0)	C
Minnesota	7.1 (6.0 to 8.2)	C+	Wisconsin	7.5 (5.9 to 9.1)	B
Mississippi	3.4 (1.5 to 5.3)	B–	Wyoming	5.0 (3.4 to 6.6)	C–
Missouri	6.1 (4.0 to 8.2)	B–	All respondents	4.2 (3.9 to 4.4)	

*Among BRFSS respondents who reported drinking at least one alcoholic beverage in the month before the survey, percentage of respondents who gave a response of one or more times to the question, "During the past month, how many times have you driven when you've had perhaps too much to drink?"
†Mothers Against Drunk Driving's aggregate state grade for the *Rating the States 2000* survey.
CI, confidence interval.

vehicle impoundment for repeat DUI offenders, vehicle forfeiture, alcohol ignition interlocks for convicted offenders, and mandatory alcohol assessment and treatment for DUI offenders.

The grades for each of the categories were combined to produce the MADD aggregate letter grade. The aggregate grade was calculated using the following weights: 30% to presence of DUI laws; 30% to trends in percentage of traffic fatalities that were alcohol related based on the National Highway Traffic Safety Administration's Fatality Analysis Reporting System[1]; 10% to DUI enforcement; and 30% to the remaining six components of the survey. Lastly, the aggregate grades were reviewed. To retain a straight "A" aggregate grade, a state had to have an administrative license revocation law, a 0.08% BAC law, and a primary enforcement safety belt law.[11] If a state lacked one or more of these three high priority DUI laws, it could receive an aggregate grade no higher than "A–". For this study, we used the aggregate letter grade rather than one of many possible combinations of the category specific grades because the aggregate grade best represents each state's comprehensive efforts to reduce alcohol impaired driving.

Information on self reported alcohol impaired driving was available from residents of every state and the District of Columbia from the 1997 Behavioral Risk Factor Surveillance System (BRFSS) survey. The BRFSS is a state based, random digit dialed telephone survey that collects information on health related behaviors from a representative sample of civilian, non-institutionalized adults aged 18 years and older.[12] In the alcohol section of the survey, respondents were asked: "During the past month, have you had at least one drink of any alcoholic beverage such as beer, wine, wine coolers, or liquor?" Those who responded "yes" were asked additional questions about alcohol consumption and alcohol impaired driving.

We restricted the study population to BRFSS respondents who reported consuming alcohol during the month preceding the survey to optimize the precision of the risk estimates for alcohol impaired driving. Alcohol impaired driving was defined as any positive response (that is, one or more) to the following question: "During the past month, how many times have you driven when you've had perhaps too much to drink?" We dichotomized the response into either has or has not driven while impaired by alcohol at least once in the month preceding the survey. This value was then weighted to the age, sex, and racial group specific population of the state.

Each BRFSS respondent was assigned the MADD aggregate letter grade ("+" or "–" was ignored) for his or her state, and we measured the association between the MADD grade and alcohol impaired driving using multiple logistic regression. Covariates available from BRFSS included age, sex, race, education, and marital status. We used indicator variables to represent the categories of the MADD grade and all covariates. Covariates were considered confounders if their removal from the model resulted in at least a 10% change in an effect estimate for alcohol impaired driving.[13] SUDAAN software was used to produce the estimated percentages and odds ratios to account for the weighted, clustered, and stratified design of the BRFSS sample.[14] Because the sale of alcohol to persons younger than 21 years is illegal in all states, we categorized the age variable to include a separate stratum for persons aged 18–20 years. Because rates of impaired driving differ by sex, we constructed separate logistic models for men and women in addition to the model containing all respondents.

RESULTS

In 1997, the BRFSS interviewed 133 321 adults living in the United States; state samples ranged from 1505 to 4923. The median state response rate (the ratio of completed interviews to the sum of completed interviews, terminated interviews, and refusals) was 76.5% (range 45.6% to 92.7%).[15] Nearly half

Table 2 Estimated percentage of adults aged 18 years or older who consume alcohol who reported alcohol impaired driving, by MADD state grade and individual characteristics

Characteristic	Men (n=31657)		Women (n=32505)		Total (n=64162)	
	%*	95% CI	%*	95% CI	%*	95% CI
MADD state grade†						
A	5.3	4.3 to 6.4	1.9	1.3 to 2.4	3.8	3.2 to 4.5
B	5.7	5.2 to 6.2	1.9	1.6 to 2.2	4.0	3.7 to 4.4
C	6.3	5.5 to 7.1	2.5	2.0 to 2.9	4.6	4.1 to 5.1
D	7.7	6.3 to 9.1	3.6	2.6 to 4.6	6.0	5.0 to 6.9
Age (years)						
18–20	11.0	8.0 to 14.0	3.6	2.2 to 5.0	7.8	6.0 to 9.7
21–24	9.8	7.8 to 11.8	3.6	2.6 to 4.7	7.1	5.9 to 8.3
25–34	8.1	7.1 to 9.1	3.4	2.8 to 4.0	6.1	5.5 to 6.8
35–54	4.9	4.4 to 5.5	1.7	1.4 to 2.0	3.5	3.2 to 3.8
≥55	2.0	1.4 to 2.4	0.6	0.3 to 0.8	1.3	1.0 to 1.6
Race/ethnicity						
Black, non-Hispanic	4.2	2.9 to 5.5	2.3	1.3 to 3.2	3.3	2.5 to 4.2
White, non-Hispanic	5.9	5.4 to 6.3	2.0	1.8 to 2.3	4.1	3.9 to 4.4
Hispanic	6.8	5.0 to 8.5	2.5	1.5 to 3.5	5.2	4.0 to 6.3
Other	5.6	3.4 to 7.7	2.5	1.2 to 3.9	4.4	3.0 to 5.7
Education						
<High school	4.5	3.2 to 5.7	2.4	1.5 to 3.4	3.8	2.9 to 4.7
High school graduate	6.8	5.9 to 7.6	2.3	1.8 to 2.8	4.8	4.3 to 5.3
Some college	6.7	5.9 to 7.6	2.0	1.7 to 2.4	4.5	4.0 to 5.0
College graduate	4.6	4.0 to 5.2	1.9	1.5 to 2.3	3.4	3.0 to 3.8
Marital status						
Married or coupled	4.5	4.0 to 5.0	1.5	1.2 to 1.7	3.2	2.9 to 3.5
Single	8.1	7.4 to 8.9	3.1	2.7 to 3.5	5.8	5.4 to 6.3
Sex						
Female	–	–	–	–	2.1	1.9 to 2.3
Male	–	–	–	–	5.8	5.4 to 6.2

*Among BRFSS respondents who reported drinking at least one alcoholic beverage in the month before the survey, percentage of respondents who gave a response of one or more times to the question, "During the past month, how many times have you driven when you've had perhaps too much to drink?"
†Mothers Against Drunk Driving's aggregate state grade for the *Rating the States 2000* survey.
CI, confidence interval.

of all BRFSS respondents reported drinking alcohol during the month preceding the interview (n=64 473). The proportion of respondents who reported drinking alcohol varied across states from 28% in Utah to 70% in Wisconsin. We excluded respondents who reported not drinking alcohol during the month preceding the interview and those with missing values for the alcohol impaired driving question (n=311), leaving a study population of 64 162 respondents.

Table 1 presents the estimated percentage of respondents from each state who drove while impaired and each state's MADD grade. Table 2 presents the estimated percentage of respondents who drove while impaired by MADD grade and each of the covariates. The percentage of persons reporting alcohol impaired driving increased as the MADD grade declined, with 3.8% (95% confidence interval (CI) 3.2% to 4.5%) of residents of "A" states and 6.0% (95% CI 5.0% to 6.9%) of residents of "D" states reporting the behavior.

None of the covariates confounded the association between MADD grade and alcohol impaired driving in the multivariate analysis. Variables representing age, sex, and marital status were retained in the regression models for descriptive purposes. Removing race and level of education from the models did not materially change the odds ratios for any of the remaining covariates and improved the precision of some of the effect estimates.

The pattern of increased risk for alcohol impaired driving among persons living in states with lower MADD grades persisted in the multivariate analysis (table 3). Persons living in states that received a MADD grade of "D" were 60% more likely to report alcohol impaired driving than those living in a state that received an "A" (odds ratio 1.6, 95% CI 1.3 to 2.1). The association existed for males and females.

Age was the strongest predictor of alcohol impaired driving. Overall, persons aged 18–20 years, who are too young to legally purchase alcohol, were more likely to report alcohol impaired driving than any other age group. Men were nearly three times as likely as women to drive while impaired, and single people were about 50% more likely to report the behavior as married people or people living with a partner.

To see if the association between MADD grade and alcohol impaired driving could be generalized to the entire population including persons who did not drink alcohol in the month preceding the survey, we repeated the primary analysis using all BRFSS respondents. This analysis produced odds ratios for alcohol impaired driving by MADD grade that were not materially different from those seen in the primary analysis (for example, the odds ratio for MADD grade of "D" versus "A" for the total population is 1.7, 95% CI 1.3 to 2.2). Including persons who do not drink alcohol, however, did alter some of the risk estimates for the individual level covariates. Thus, the risk estimates reported for age, sex, and marital status apply only to persons who report drinking alcohol and cannot be generalized to the entire population.

Thirty per cent of each state's MADD grade represented the state's trend in alcohol related traffic fatalities. The fatality trends are included in the MADD grade as a crude measure of the effectiveness of each state's DUI countermeasures. Because these trends are an outcome measure rather than an actual countermeasure, we repeated the logistic regression analysis after removing the fatality trends component of the MADD grade and reweighting the grade using the remaining eight components of the survey. The reweighted grades differed from the grades used in the primary analysis for four states (Arkansas = C; New York = C; Oregon = A; Wyoming = D). The association between MADD grade and alcohol impaired driving seen in the primary analysis persisted, with the odds ratios for the behavior among persons living in states with a MADD grade

Table 3 Risk of self reported alcohol impaired driving among adults aged 18 years or older who consume alcohol

Characteristic	Men (n=31606)		Women (n=32421)		Total (n=64027)†	
	AOR*	95% CI	AOR*	95% CI	AOR*	95% CI
MADD state grade‡						
A	1.0		1.0		1.0	
B	1.1	0.9 to 1.4	1.0	0.7 to 1.4	1.1	0.9 to 1.3
C	1.2	0.9 to 1.5	1.3	0.9 to 1.8	1.2	1.0 to 1.5
D	1.5	1.1 to 2.1	2.0	1.3 to 3.1	1.6	1.3 to 2.1
Age (years)						
18–20	4.8	3.2 to 7.3	4.9	2.6 to 9.3	4.8	3.4 to 6.7
21–24	4.5	3.1 to 6.4	5.6	3.2 to 10.0	4.6	3.4 to 6.2
25–34	4.1	3.1 to 5.4	6.3	3.8 to 10.5	4.4	3.5 to 5.7
35–54	2.6	1.9 to 3.4	3.3	2.0 to 5.5	2.7	2.1 to 3.4
≥55	1.0		1.0		1.0	
Marital status						
Married or coupled	1.0		1.0		1.0	
Single	1.4	1.2 to 1.7	2.0	1.6 to 2.5	1.5	1.3 to 1.8
Sex						
Female	–		–		1.0	
Male	–		–		2.9	2.5 to 3.3

*AOR, odds ratios are adjusted for other variables in the column.
†135 records that were missing data on marital status or age were excluded from the multivariate analysis.
‡Mothers Against Drunk Driving's aggregate state grade from the *Rating the States 2000* survey.
CI, confidence interval.

of "D" versus "A" as follows: OR_{males} = 1.4 (95% CI 1.0 to 1.9); $OR_{females}$ = 1.9 (95% CI 1.2 to 2.9); and OR_{total} = 1.5 (95% CI 1.2 to 1.9).

DISCUSSION
In this study, we used scores from the MADD *Rating the States 2000* survey as an index of each state's comprehensive DUI prevention activities to explore the relation between environmental level influences and individuals' drinking and driving behavior. We found that residents from states with weaker DUI countermeasures were more likely to drive while impaired.

This study adds to existing evidence of the problem of impaired driving among adolescents and underage adults who drink alcohol.[2] [16–18] We found that among BRFSS respondents who reported drinking alcohol during the month preceding the survey, persons aged 18–20 years were more likely to report driving while impaired than any other age group. Rigorous enforcement of zero tolerance laws and minimum legal drinking age laws[19] and strengthened community based efforts to limit minors' access to alcohol may help reduce drinking and driving in this age group.[20]

This study has limitations. The BRFSS impaired driving question provides a subjective appraisal of the respondents' level of impairment while driving. Respondents may underestimate or overestimate their level of impairment, and the relation between self reported alcohol impaired driving and actual driving with a blood alcohol concentration that exceeds the legal limit has not been examined. However, of the BRFSS respondents who reported driving after having "perhaps too much to drink" in the month before the survey, 85% also reported drinking five or more drinks on an occasion. This finding suggests that respondents may use a high threshold when deciding how much is "perhaps too much" to drink before driving.

Some BRFSS respondents may under-report drinking and driving because the behavior carries a social stigma. It is possible that respondents who live in states with stronger DUI countermeasures may be more likely to under-report drinking and driving. This type of systematic under-reporting of drinking and driving could bias risk estimates away from the null value. On the other hand, some people report that they can drive safely even after consuming up to 12 alcoholic beverages.[21] Systematic under-reporting of drinking and driving by heavy drinkers who engage in the behavior could bias risk estimates toward the null value. The actual effect that any under-reporting of impaired driving may have had on the findings of this study, however, cannot be determined with existing data.

The MADD *Rating the States* survey was designed as a media advocacy tool. To our knowledge, this study is the first to apply the survey results to research. The survey collects information at the state level. Implementation and enforcement of DUI countermeasures varies across communities within the same state. In addition, the three states assigned a grade of "D" (North Dakota, South Dakota, and Montana) are contiguous, and they may share unique social and demographic factors that could potentially affect the generalizability of the study results (for example, low population density, attitudes toward governmental regulation).

Finally, because of the study's cross sectional design, we cannot empirically explore the direction of the association between DUI countermeasures and individual drinking and driving behavior. It is likely that the association is reciprocal, with individual attitudes influencing the implementation of DUI countermeasures and vice versa.

In January 1995, the US Department of Transportation established a national goal to reduce alcohol related traffic fatalities by 37% to no more than 11 000 by 2005.[22] In accordance with this goal, the US Department of Health and Human Services established the *Healthy People 2010* objective to reduce alcohol related traffic fatalities to no more than four per 100 000 by 2010.[23] To meet the goal, the nation must further curtail impaired driving, community-by-community, state-by-state. This study adds to the growing body of literature suggesting that strong DUI countermeasures are an important component of a comprehensive approach to reducing alcohol impaired driving and alcohol related traffic fatalities.[2] [5] [6] [9] [20] [22] [24]

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LACU NAE ....

Schoolboy loses legs in explosion

A 16 year old Pretoria boy lost both his legs after a home experiment went horribly wrong. Waldo van der Westhuizen, of Menlo Park High School in Pretoria, South Africa, had been mixing chemicals in his room when there was a reaction, followed by an explosion. Doctors amputated both his legs just below the knees.

The incident had happened just after 4 pm. The boy and his brother had been alone at home. "He was in his room busy mixing chemicals when he apparently put the wrong chemicals together and it exploded". Waldo's younger brother, Renier, was only slightly injured. Captain Deon Stidwell, of the Explosives Unit, said they did not believe that the boy was trying to make a bomb. "He is a young boy with a vivid imagination who liked to play with chemicals". Waldo's mother confirmed he was interested in science and said he did a lot of experiments at home. It is believed he was busy with an experiment, which he wanted to demonstrate to other pupils at school. Police could not confirm if the recipe Waldo was using came off the internet. "There are a lot of chemistry books inside the house, but this type of [bomb] recipe is widely available on the internet", Stidwell said (*Cape Argus* (Cape Town), September 2001). (Contributed by Nelmarie du Toit.)

Children in France urged to turn in toy guns

As a sign of solidarity with children in war zones, children in France are being urged to turn in their toy guns, the BBC reported on November 14. The non-profit group Medecins du Monde is calling on the country's four million children between the ages of 7 and 12 to give up their plastic guns as a symbolic gesture. The effort is aimed at raising children's understanding of war and making French children aware of how fortunate they are compared with children who experience war for real. "Children should try to do something that adults couldn't do in reality—to accept and be aware of the suffering of people and to try to do something about it", said Cristalle Boulanger of Medecins du Monde. The toys guns that are turned in will be made into a sculpture that will form a signpost pointing to different conflict zones, including Kabul and Sarajevo (from www.jointogether.org). (Contributed by Les Fisher.)