Original Contribution

Effectiveness of Mandatory Alcohol Testing Programs in Reducing Alcohol Involvement in Fatal Motor Carrier Crashes

Joanne E. Brady, Susan P. Baker, Charles DiMaggio, Melissa L. McCarthy, George W. Rebok, and Guohua Li

Initially submitted March 25, 2009; accepted for publication June 12, 2009.

Mandatory alcohol testing programs for motor carrier drivers were implemented in the United States in 1995 and have not been adequately evaluated. Using data from the Fatality Analysis Reporting System during 1982–2006, the authors assessed the effectiveness of mandatory alcohol testing programs in reducing alcohol involvement in fatal motor carrier crashes. The study sample consisted of 69,295 motor carrier drivers and 83,436 non-motor-carrier drivers who were involved in 66,138 fatal multivehicle crashes. Overall, 2.7% of the motor carrier drivers and 19.4% of the non-motor-carrier drivers had positive blood alcohol concentrations. During the study period, the prevalence of alcohol involvement in fatal crashes decreased by 80% among motor carrier drivers and 41% among non-motor-carrier drivers. With adjustment for driver age, sex, history of driving while intoxicated, and survival status, implementation of the mandatory alcohol testing programs was found to be associated with a 23% reduced risk of alcohol involvement in fatal crashes by motor carrier drivers (odds ratio = 0.77, 95% confidence interval: 0.62, 0.94). Results from this study indicate that mandatory alcohol testing programs may have contributed to a significant reduction in alcohol involvement in fatal motor carrier crashes.

accidents; traffic; alcohol drinking; occupational health; public policy; research; safety; wounds and injuries

Abbreviations: BAC, blood alcohol concentration; DWI, driving while intoxicated; FARS, Fatality Analysis Reporting System.

Cognitive functions, such as divided attention, reaction time, depth perception, information processing, and decision making, are known to be sensitive to the adverse effects of alcohol (1, 2). Alcohol at doses as low as 0.01–0.04 g/dL can impair driving performance (3). The risk of being involved in a fatal crash increases exponentially with the driver's blood alcohol concentration (BAC) (4). Despite intensive interventions, alcohol-impaired driving remains a serious public health problem, claiming about 17,000 lives each year in the United States (5).

Previous research on alcohol and traffic injury is primarily limited to car drivers. Commercial motor vehicles make up about 4% of police-reported crashes and 12% of traffic fatalities (6). The role of alcohol in commercial motor vehicle crashes was first recognized in the 1970s. Baker (7) analyzed the toxicologic testing data for 25 fatally injured tractor-trailer drivers and found that 8 (32%) of them had

BACs ≥ 0.10 g/dL. Subsequent studies indicate that the prevalence of positive BACs in fatally injured commercial truck drivers has decreased progressively in the past 3 decades (7–9). The prevalence of alcohol dependence among commercial truck drivers has also declined, from about 10% in the early 1990s to 2% in the 2000s (10, 11). Random alcohol testing at weighing stations suggests that about 1% of commercial truck drivers have positive BACs (12, 13).

Prompted by a series of highly publicized alcohol-related transportation incidents, including the 1989 Exxon Valdez oil spill in Alaska, the 1990 conviction of 3 Northwest Airlines pilots, and the 1991 New York City subway derailment, the US Congress enacted the Omnibus Transportation Employee Testing Act of 1991, making alcohol testing mandatory for transportation employees with safety-sensitive functions (14). The mandatory alcohol testing

programs are implemented by the operational agencies of the US Department of Transportation under the guidelines codified in 49 CFR Part 40 ("Procedures for Transportation Workplace Drug and Alcohol Testing Program"). These guidelines prescribe the procedural protocols for conducting alcohol tests by covered employers. The rules and procedures for alcohol testing of motor carrier drivers are specified by the Federal Motor Carrier Safety Administration in 49 CFR Part 382 ("Controlled Substances and Alcohol Use and Testing") (15). The term "motor carrier drivers" refers to operators of commercial motor vehicles with a gross vehicle weight rating of more than 26,000 pounds (11,797 kg).

Implemented on January 1, 1995, the mandatory alcohol testing programs for motor carrier drivers include preemployment testing, random testing, reasonable suspicion testing, and postaccident testing. Preemployment testing is conducted after a contingent job offer has been made. Random testing requires that randomly sampled employees report to the test site immediately before, during, or immediately after their driving shift. The percentages of motor carrier drivers being tested for alcohol under the random testing program each year were approximately 25% from 1995 to 1997 and 10% from 1998 to 2006. Motor carrier drivers with BACs ≥ 0.04 g/dL (i.e., the legal limit) are suspended immediately. Those who register a BAC of 0.02–0.03 g/dL are removed from duty for 24 hours. Reasonable suspicion testing allows employers to require a covered employee to submit to alcohol testing if the employee's appearance, behavior, speech, or breath/body odor shows signs of being under the influence of alcohol. In the case of an accident, all involved drivers are required to submit to an alcohol test within 2 hours (15). Alcohol tests under the mandatory testing programs are conducted by certified technicians using devices (primarily evidential breath testing devices) approved by the National Highway Traffic Safety Administration. Each year, approximately 500,000 alcohol tests are performed on motor carrier drivers (16).

The mandatory alcohol testing programs for transportation employees with safety-sensitive functions represent a major policy intervention. This policy is controversial, however. In addition to legal and ethical concerns, there is little information about its safety benefit (17, 18). The present study aimed to test the hypothesis that implementation of the mandatory alcohol testing programs in 1995 is associated with a significantly decreased risk of alcohol involvement in fatal motor carrier crashes.

MATERIALS AND METHODS

Data source

Data for this study were derived from the Fatality Analysis Reporting System (FARS) for the years 1982–2006. Sponsored by the National Highway Traffic Safety Administration, FARS is a census of fatal traffic crashes occurring within the United States. To be included in FARS, a crash must involve a motor vehicle traveling on a public road that results in a fatality within 30 days of the crash. FARS contains detailed data on the circumstances, vehicles, and

people involved in the crash, collected through standard forms, protocols, and quality control procedures (19, 20).

Study sample

During 1982–2006, FARS recorded a total of 83,539 fatal crashes involving motor carriers. Excluded from the analysis were 15,743 crashes involving only a single motor carrier and 1,658 crashes involving multiple motor carriers but no other vehicle. The study sample comprised the remaining 66,138 crashes, which involved 69,295 motor carrier drivers and 83,436 non-motor-carrier drivers.

Study design

A quasi-experimental design was used to assess the association between implementation of the mandatory alcohol testing programs and the risk of alcohol involvement in fatal crashes by motor carrier drivers. The study period covered 13 years preimplementation (1982–1994) and 12 years postimplementation (1995–2006). While the annual sequential observational data during the study period formed the basic tenet of a time series, drivers included in this study constituted a dynamic cohort, which consisted of 2 subcohorts (i.e., motor carrier drivers and non-motor-carrier drivers) matched on tempo-spatial variables (21).

Alcohol information

Driver alcohol involvement in a given crash was defined by a BAC ≥ 0.01 g/dL. BAC information was available for only 40% of the study sample. Although drivers with and without BAC information were similar regarding demographic characteristics and crash circumstances, those not tested for alcohol were significantly more likely than those tested to have survived the crash (22). To address the missing data issue, the National Highway Traffic Safety Administration has developed a multiple imputation algorithm that provides statistically robust estimates for missing BAC values. The multiple imputation algorithm generates 10 estimated BAC values for each driver with missing BAC data. Variation in the 10 imputed BAC values accounts for uncertainty in the estimation of missing BAC values and enables proper estimation of variances, standard deviations, and confidence intervals (23–26).

The multiply imputed BAC values are created by first constructing a statistical model for each vehicle class. In the stepwise log-linear regression model for a given vehicle class, dichotomous BAC values (0 vs. >0) are predicted by using the following categorical variables: police-reported alcohol involvement, age, sex, use of a seat belt or helmet, injury severity, license status, indicator of prior traffic convictions, day of the week, time of day, vehicle role (striking/struck vehicle), and an indicator of whether the crash occurred on the roadway or shoulder. If the missing BAC value is predicted to be greater than 0, then a linear regression model is created to provide a quantitative estimate of the missing BAC value. Box-Cox transformations are used to transform the log of BAC level, and stepwise linear regression is used to determine whether the covariates evaluated

for inclusion in the log-linear model would be included in the linear regression model. Finally, multiple imputation estimates are created by using a general location model. The imputation is simulated 10 times, and imputed values are transformed back to the BAC scale (22–26). Use of the multiple imputation data in this study followed the guidelines recommended by Klebanoff and Cole (27).

Statistical analysis

The following logistic regression model (9) was constructed to assess the effectiveness of mandatory alcohol testing programs in reducing the risk of alcohol involvement in fatal crashes by motor carrier drivers:

$$\begin{aligned} \text{Ln}(p/1 - p) = & b_0 + b_1(\text{driver type}) \\ & + b_2(\text{mandatory alcohol testing}) \\ & + b_3(\text{driver type} \\ & \times \text{mandatory alcohol testing}) + \mathbf{B}\mathbf{X}, \end{aligned}$$

where p is the probability of $\text{BAC} \geq 0.01$ g/dL for the driver involved in a fatal crash, *driver type* is an indicator of whether the driver was operating a motor carrier (1 for motor carrier drivers, 0 for other drivers), *mandatory alcohol testing* is an indicator of whether the fatal crash occurred before or after implementation of mandatory alcohol testing programs (0 for 1982–1994, 1 for 1995–2006), and $\mathbf{X}$ represents a vector of covariates to control for possible confounders, including driver age, sex, history of driving while intoxicated (DWI), and survival status. DWI history refers to whether the driver had any recorded DWI conviction during the 3 years preceding the crash, and survival status refers to whether the driver died because of injury within 30 days of the crash.

In the aforementioned model, b_0 is the intercept; b_1 is the logarithm of the relative odds of alcohol involvement by motor carrier drivers versus non-motor-carrier drivers before implementation of the mandatory alcohol testing programs (1982–1994); b_2 is the logarithm of the relative odds of alcohol involvement by non-motor-carrier drivers after versus before implementation of the mandatory alcohol testing programs; $b_1 + b_3$ is the logarithm of the relative odds of alcohol involvement by motor carrier drivers versus non-motor-carrier drivers after implementation of the mandatory alcohol testing programs (1995–2006); and $b_2 + b_3$ is the logarithm of the relative odds of alcohol involvement by motor carrier drivers after versus before implementation of the mandatory alcohol testing program. The regression coefficient for the interaction term, b_3 , is numerically the linear contrast of $(b_2 + b_3) - b_2$ and thus can be interpreted as the net effect of mandatory alcohol testing programs on the risk of alcohol involvement by motor carrier drivers. $\mathbf{B}$ represents the vector of regression coefficients for $\mathbf{X}$.

To assess the robustness of the estimated effect of mandatory alcohol testing programs on alcohol involvement in fatal crashes by motor carrier drivers, we compared the results from the multivariate logistic model based on multiply imputed BAC data with those based on actual BAC testing data. Separate models were also fitted by using data

Table 1. Characteristics of Drivers in Fatal Multivehicle Crashes Involving Motor Carriers in the United States, by Driver Type, Fatality Analysis Reporting System, 1982–2006

Driver Characteristic	Motor Carrier Drivers		Other Drivers		Total	
	No. ^a	%	No. ^a	%	No. ^a	%
Age, years						
<25	3,997	5.8	18,193	21.9	22,190	14.6
25–34	18,042	26.1	17,369	20.9	35,411	23.3
35–44	20,783	30.0	14,863	17.9	35,646	23.4
45–54	16,309	23.6	11,156	13.4	27,465	18.1
55–64	8,475	12.3	8,154	9.8	16,629	10.9
≥65	1,571	2.3	13,281	16.0	14,852	9.8
Sex						
Male	67,328	97.3	58,166	70.0	125,494	82.4
Female	1,897	2.7	24,960	30.0	26,857	17.6
DWI conviction in the past 3 years						
Yes	811	1.2	2,549	3.1	3,360	2.3
No	66,955	98.8	78,805	96.9	145,760	97.7
Imputed BAC, g/dL						
≥0.01	1,851	2.7	16,178	19.4	18,029	11.8
0.00	67,444	97.3	67,258	80.6	134,701	88.2
Tested BAC, g/dL						
≥0.01	583	3.2	11,466	27.2	12,049	19.9
0.00	17,870	96.8	30,731	72.8	48,601	80.1
Survival status						
Died	2,261	3.3	55,016	66.2	57,277	37.6
Alive	66,901	96.7	28,133	33.8	95,034	62.4

Abbreviations: BAC, blood alcohol concentration; DWI, driving while intoxicated.

^a The total number of drivers for certain variables may vary because of missing data.

stratified by driver age, sex, or time of crash. Data analyses were performed by using Statistical Analysis Software, version 9.1.3 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

The study sample accounted for 79% of all fatal motor carrier crashes and 78% of all motor carrier drivers involved in fatal crashes during 1982–2006. Motor carrier drivers included in the analysis ($n = 69,295$) and those excluded ($n = 19,288$) were similar regarding age and sex, prevalence of positive DWI history, and year of crash, but they differed substantially in BACs and survival status. Specifically, motor carrier drivers excluded from the analysis were more likely than those included to be involved in crashes occurring at night, have positive BACs, and be fatally injured.

Driver characteristics differed markedly between motor carrier drivers and other drivers in the study sample (Table 1). The overwhelming majority of motor carrier drivers were adults aged 25–64 years, were male, had no DWI history,

Figure 1. Percentage of drivers involved in fatal multivehicle motor carrier crashes with imputed blood alcohol concentrations ≥ 0.01 g/dL, by year and driver type, United States, Fatality Analysis Reporting System, 1982–2006.

and survived the crash. Compared with motor carrier drivers, other drivers in the study sample were more likely to be aged <25 or ≥ 65 years, be female, have a positive DWI history, be alcohol positive, and have died from the crash (Table 1). The prevalence of alcohol involvement among other drivers was substantially higher than among motor carrier drivers throughout the study period (Figure 1). Between 1982 and 2006, the prevalence of alcohol involvement in fatal crashes declined by 80% for motor carrier drivers and 41% for other drivers (Figure 1). As a result of the study design, the 2 groups of drivers were closely matched on crash circumstances (Table 2).

Multivariate logistic regression modeling based on multiply imputed BAC data revealed that implementation of mandatory alcohol testing programs was associated with a 23% reduction (adjusted odds ratio = 0.77, 95% confidence interval: 0.62, 0.94) in alcohol involvement by motor carrier drivers. Specifically, the estimated odds ratios of alcohol involvement by motor carrier drivers versus other drivers were 0.21 and 0.16 for the pre- and postimplementation periods, respectively; compared with those for the preimplementation period, the odds of alcohol involvement after implementation of the mandatory alcohol testing programs were reduced by 48% (adjusted odds ratio = 0.52, 95% confidence interval: 0.43, 0.64) for motor carrier drivers and 32% (adjusted odds ratio = 0.68, 95% confidence interval: 0.65, 0.71) for other drivers. Significantly heightened risk of alcohol involvement was also found for drivers who were 25–34 years of age, were male, had a positive DWI history, or were fatally injured (Table 3). When the model was fitted by using actual alcohol testing data, the estimated effect of the mandatory alcohol testing programs on alcohol involvement by motor carrier drivers was modestly greater than the estimate based on multiply imputed data (adjusted odds ratio = 0.69, 95% confidence interval: 0.58, 0.82; Table 3).

The estimated effect of the mandatory alcohol testing programs on alcohol involvement by motor carrier drivers remained fairly stable when the analysis was performed by using multiply imputed BAC data stratified by driver age, sex, or time of crash (Table 4). For instance, implementation of the mandatory alcohol testing programs was associated with a 24% reduction in the risk of alcohol involvement by motor carrier drivers in daytime fatal crashes (adjusted odds ratio = 0.76, 95% confidence interval: 0.59, 0.96) and a 26% reduction in nighttime fatal crashes (adjusted odds ratio = 0.74, 95% confidence interval: 0.58, 0.94). Including in the analysis the 19,288 drivers involved in single-vehicle motor carrier crashes or crashes involving more than one motor carrier but no other vehicle attenuated the estimated effect size slightly (adjusted odds ratio = 0.79, 95% confidence interval: 0.68, 0.91).

DISCUSSION

The results of this study indicate that implementation of the mandatory alcohol testing programs in 1995 is associated with a 23% reduction in alcohol involvement in fatal crashes by motor carrier drivers. The estimated safety benefit of the mandatory alcohol testing programs is consistent across age groups and between sexes. Moreover, implementation of these programs has reduced alcohol involvement by motor carrier drivers in daytime and nighttime fatal crashes to a similar degree.

Evidence for the effectiveness of the mandatory alcohol testing programs in reducing alcohol-related crashes is strengthened by the study design and statistical approach. Controlling for confounding factors, particularly unmeasured confounders, is a serious limitation inherent to all observational studies. This study took advantage of data on multivehicle crashes, in which motor carrier drivers were matched with the comparison drivers on tempo-spatial

Table 2. Circumstances of Fatal Multivehicle Crashes Involving Motor Carriers in the United States, by Driver Type, Fatality Analysis Reporting System, 1982–2006

Crash Characteristic	Motor Carriers		Other Vehicles		Total	
	No. ^a	%	No. ^a	%	No. ^a	%
Fire						
Yes	2,639	3.8	4,270	5.1	6,909	4.5
No	66,656	96.2	79,166	94.9	145,822	95.5
Rollover						
First event	500	0.7	386	0.5	886	0.6
Subsequent event	4,894	7.1	4,778	5.7	9,672	6.3
No rollover	63,901	92.2	78,272	93.8	142,173	93.1
Region						
Northeast	7,606	11.0	9,336	11.2	16,942	11.1
Midwest	18,023	26.0	21,253	25.5	39,276	25.7
South	33,128	47.8	39,281	47.1	72,409	47.4
West	10,538	15.2	13,566	16.3	24,104	15.8
Year of crash						
1982–1984	4,428	6.4	5,206	6.2	9,634	6.3
1985–1989	11,805	17.0	14,299	17.1	26,104	17.1
1990–1994	12,954	18.7	15,581	18.7	28,535	18.7
1995–1999	15,433	22.3	18,665	22.4	34,098	22.3
2000–2004	17,718	25.6	21,368	25.6	39,086	25.6
2005–2006	6,957	10.0	8,317	10.0	15,274	10.0
Month of crash						
January–March	15,853	22.9	18,994	22.8	34,847	22.8
April–June	16,845	24.3	20,331	24.4	37,176	24.3
July–September	18,039	26.0	21,876	26.2	39,915	26.1
October–December	18,558	26.8	22,235	26.7	40,793	26.7
Day of crash						
Monday–Thursday	46,063	66.5	55,099	66.0	101,162	66.2
Friday–Sunday	23,231	33.5	28,336	34.0	51,567	33.8
Time of crash						
Day (7:00 AM–6:59 PM)	45,181	65.2	56,429	67.7	101,610	66.6
Night (7:00 PM–6:59 AM)	24,088	34.8	26,980	32.3	51,068	33.4

^a The total numbers within variables may vary because of missing data.

variables both measured (e.g., year, month, day of the week, time of day of the crash, geographic region, US state, location, road conditions, weather conditions) and unmeasured (e.g., socioeconomic environment, regulatory changes other than the mandatory alcohol testing program, and variations in law enforcement). The study design made it possible to substantially reduce the effect of confounding factors. Inclusion of the interaction term between driver type and presence/absence of the intervention in the statistical model enabled us to construct a series of linear contrasts based on the regression coefficients and to interpret the results from the logistic regression models with clarity.

Matching on tempo-spatial variables in multivehicle crash data provides considerable advantages for bias control. This feature is especially appealing in studies of fatal motor carrier crashes because 79% of these crashes are col-

lisions between motor carriers and other vehicles. Although only 19% of fatal motor carrier crashes involved a single vehicle, they accounted for 66% of motor carrier driver fatalities. The estimated effect of mandatory alcohol testing programs on alcohol involvement in fatal crashes by motor carrier drivers appears to be robust. Including single-vehicle crashes and multi-motor-carrier crashes in the analysis attenuated the estimated effect size from –23% to –21%. Snowden et al. (9) analyzed FARS data from 1988 to 2003 for large-truck drivers and all light-passenger-vehicle drivers and found that implementation of the mandatory alcohol testing programs was associated with a 15% reduction in the risk of alcohol involvement in fatal crashes by large-truck drivers. The modest difference in the estimated effect size between the Snowden et al. report and the present study is likely due in part to the different study designs.

Table 3. Estimated Relative Odds of Alcohol Involvement^a From Multivariate Logistic Regression, United States, Fatality Analysis Reporting System, 1982–2006

	Model 1: Multiply Imputed Alcohol Data (n = 148,849)		Model 2: Actual Alcohol Testing Data (n = 59,373)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Driver type (motor carrier driver vs. other driver)	0.21	0.19, 0.24	0.10	0.09, 0.12
Mandatory alcohol testing (yes vs. no)	0.68	0.65, 0.71	0.64	0.61, 0.67
Driver type × mandatory alcohol testing	0.77	0.62, 0.94	0.69	0.58, 0.82
Age, years				
<25	0.92	0.87, 0.98	0.85	0.80, 0.91
25–34	1.23	1.16, 1.30	1.23	1.15, 1.31
45–54	0.73	0.68, 0.78	0.70	0.65, 0.76
55–64	0.50	0.46, 0.54	0.47	0.43, 0.52
≥65	0.22	0.21, 0.25	0.21	0.19, 0.23
Male sex	2.11	2.00, 2.23	2.34	2.21, 2.48
DWI conviction in the past 3 years	5.00	4.60, 5.43	6.73	6.04, 7.50
Fatally injured	3.38	3.19, 3.58	1.36	1.26, 1.47

Abbreviation: DWI, driving while intoxicated.

^a Blood alcohol concentration ≥0.01 g/dL.

Whereas matching on tempo-spatial variables should enhance internal validity of our study results, the time-series approach by Snowden et al. might have the benefit of greater generalizability.

Our analysis also indicates that drivers who are 25–34 years of age, are male, or have a positive DWI history are at a significantly increased risk of alcohol involvement in fatal crashes. This finding, which is consistent with previous research in other driver population groups (28), may help target high-risk motor carrier drivers for interventions to further reduce alcohol-related crashes.

Table 4. Estimated Relative Odds of Alcohol Involvement^a by Motor Carrier Drivers Associated with Mandatory Alcohol Testing From Stratified Multivariate Logistic Regression, United States, Fatality Analysis Reporting System, 1982–2006

Strata	Odds Ratio	95% Confidence Interval
Age, years		
<35	0.70	0.54, 0.90
35–54	0.70	0.55, 0.89
≥55	0.68	0.48, 0.97
Sex		
Male	0.75	0.61, 0.92
Female	0.65	0.37, 1.13
Time of crash		
Day (7:00 AM–6:59 PM)	0.76	0.59, 0.96
Night (7:00 PM–6:59 AM)	0.74	0.58, 0.94

^a Multiple-imputation blood alcohol concentration ≥0.01 g/dL.

Our study has several limitations. First, our analysis relied largely on multiply imputed alcohol data because alcohol testing was performed on only 40% of the study subjects. Although multiple imputation is superior to many other missing data methods (25) and appears to mitigate information bias due to missing data, imputed BACs cannot completely substitute for actual alcohol testing results.

Second, this study did not account for other regulatory changes and interventions that might have differentially affected the likelihood of alcohol involvement in fatal crashes by motor carrier drivers and other drivers. Although the study design may have controlled for tempo-spatial variables with nondifferential effects on motor carrier drivers and other drivers, policy changes specifically targeted at 1 of the 2 groups may still threaten validity of the study results. For instance, after 1995, many states lowered the legal alcohol limit for operating a motor vehicle from 0.10 g/dL to 0.08 g/dL. This change in alcohol policy, however, should have far less impact on motor carrier drivers than on other drivers because the legal alcohol limit for motor carrier drivers has remained at 0.04 g/dL since implementation of the mandatory alcohol testing program in 1995.

Finally, our outcome variable, alcohol involvement in fatal crashes, does not directly measure the risk of alcohol-related fatal crashes. Although national statistics indicate that rates of fatal crashes involving large trucks decreased considerably during the study period (29), it is unwise to interpret the estimated reduction in alcohol involvement in fatal crashes by motor carrier drivers as a reduction in alcohol-related crashes. Moreover, this study was limited to fatal crashes. Further research is warranted to determine the effectiveness of the mandatory alcohol testing

program for motor carrier drivers in reducing alcohol involvement in nonfatal crashes.

Despite these limitations, this study provides compelling evidence that implementation of the mandatory alcohol testing programs has significantly reduced alcohol involvement in fatal motor carrier crashes. Mandatory alcohol testing programs for employees with safety-sensitive functions have been challenged in courts of law by employers on the basis of unnecessary costs and by unions on the grounds of unreasonable search in violation of the Fourth Amendment (17). Free cross-border trade by motor carriers, a major objective of the North America Free Trade Agreement, has been hindered because of safety concerns. Among the differences in regulations for motor carriers is mandatory alcohol testing, which is required of drivers in the United States but not in Canada and Mexico. Whether Canada and Mexico should adopt the mandatory alcohol testing policy for motor carrier drivers remains an outstanding issue under trilateral negotiation. Results of our study should be valuable in advancing the discourse on mandatory alcohol testing programs.

ACKNOWLEDGMENTS

Author affiliations: Department of Anesthesiology, College of Physicians and Surgeons, Columbia University, New York, New York (Joanne E. Brady, Charles DiMaggio, Guohua Li); Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, New York (Charles DiMaggio, Guohua Li); Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland (Susan P. Baker); Department of Emergency Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland (Melissa L. McCarthy); and Department of Mental Health, Johns Hopkins School of Bloomberg School of Public Health, Baltimore, Maryland (George W. Rebok).

This work was supported by grant AA009963 from the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Bethesda, Maryland.

The authors thank Barbara Lang for her editorial and administrative assistance.

Conflict of interest: none declared.

REFERENCES

- Nawrot M, Nordenstrom B, Olson A. Disruption of eye movements by ethanol intoxication affects perception of depth from motion parallax. *Psychol Sci*. 2004;15(12):858–865.
- Tzambazis K, Stough C. Alcohol impairs speed of information processing and simple and choice reaction time and differentially impairs higher-order cognitive abilities. *Alcohol Alcohol*. 2000;35(2):197–201.
- Ogden EJ, Moskowitz H. Effects of alcohol and other drugs on driver performance. *Traffic Inj Prev*. 2004;5(3):185–198.
- Zador PL, Krawchuk SA, Voas RB. Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. *J Stud Alcohol*. 2000;61(3):387–395.
- National Highway Traffic Safety Administration. *Traffic Safety Facts 2006*. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration; 2008. (DOT HS 810 818).
- Lyman S, Braver ER. Occupant deaths in large truck crashes in the United States: 25 years of experience. *Accid Anal Prev*. 2003;35(5):731–739.
- Baker SP. Alcohol in fatal tractor trailer crashes. Presented at the 19th Conference of the American Association of Automotive Medicine, San Diego, CA, November 20–22, 1975.
- Crouch DJ, Birky MM, Gust SW, et al. The prevalence of drugs and alcohol in fatally injured truck drivers. *J Forensic Sci*. 1993;38(6):1342–1353.
- Snowden CB, Miller TR, Waehrer GM, et al. Random alcohol testing reduced alcohol-involved fatal crashes of drivers of large trucks. *J Stud Alcohol Drugs*. 2007;68(5):634–640.
- Korelitz JJ, Fernandez AA, Uyeda VJ, et al. Health habits and risk factors among truck drivers visiting a health booth during a trucker trade show. *Am J Health Promot*. 1993;8(2):117–123.
- Solomon AJ, Doucette JT, Garland E, et al. Healthcare and the long haul: long distance truck drivers—a medically underserved population. *Am J Ind Med*. 2004;46(5):463–471.
- Lund AK, Preusser DF, Blomberg RD, et al. Drug use by tractor-trailer drivers. *J Forensic Sci*. 1988;33(3):648–661.
- Couper FJ, Pemberton M, Jarvis A, et al. Prevalence of drug use in commercial tractor-trailer drivers. *J Forensic Sci*. 2002;47(3):562–567.
- Hall J. Alcohol and other drug use in commercial transportation. Presented at the 13th International Conference on Alcohol, Drugs, and Traffic Safety, Adelaide, Australia, August 13–18, 1995.
- Controlled substances and alcohol use and testing. Code of Federal Regulations, Title 49, Part 382. 1995. (<http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=15c42d055987fa1700f880d1a43c91f4;rgn=div5;view=text;node=49%3A5.1.1.2.25;idno=49;cc=ecfr>).
- Federal Motor Carrier Safety Administration, Office of Research and Analysis. *Drug and Alcohol Testing Survey: 2005 Results*. Washington, DC: Federal Motor Carrier Safety Administration; 2007. (<http://www.fmcsa.dot.gov/facts-research/research-technology/analysis/FMCSA-RRA-07-014.htm>). (Accessed March 16, 2009).
- Hirsch RA. *Drug and Alcohol Testing—A Survey of Labor-Management Relations*. Washington, DC: Transportation Research Board; 2001.
- Cashman CM, Ruotsalainen JH, Greiner BA, et al. Alcohol and drug screening of occupational drivers for preventing injury [electronic article]. *Cochrane Database Syst Rev*. 2009; (2):CD006566.
- National Highway Traffic Safety Administration, National Center for Statistics and Analysis. *Fatality Analysis Reporting System (FARS)*. Washington, DC: National Highway Traffic Safety Administration; 2001. (<http://www.nhtsa.dot.gov/people/ncsa/fars.html>). (Accessed October 15, 2008).
- National Highway Traffic Safety Administration, National Center for Statistics and Analysis. *Fatality Analysis Reporting System (FARS) Overview*. Washington, DC: National Highway Traffic Safety Administration; 2006. (http://www.nhtsa.dot.gov/portal/site/nhtsa/template.MAXIMIZE/menuitem.9fef9613e59b4dd24ec86e10dba046a0/?javax.portlet.tpst=4670b93a0b088a006bc1d6b760008a0c_ws_MX&javax.portlet.prp_4670b93a0b088a006bc1d6b760008a0c_viewID=detail_

- view&javax.portlet.begCacheTok=com.vignette.cachetoken&javax.portlet.endCacheTok = com.vignette.cachetoken&itemID=c9e01829d5c9f010VgnVCM1000002c567798RCRD&overrideViewName = Article). (Accessed March 20, 2009).
21. Braver ER, Kufera JA, Alexander MT, et al. Using head-on collisions to compare risk of driver death by frontal air bag generation: a matched-pair cohort study. *Am J Epidemiol*. 2008;167(5):546–552.
 22. McCarthy ML, Sheng P, Baker SP, et al. Validity of police-reported alcohol involvement in fatal motor carrier crashes in the United States between 1982 and 2005. *J Safety Res*. 2009; 40(3):227–232.
 23. National Highway Traffic Safety Administration, National Center for Statistics & Analysis-Research & Development. *Multiple Imputation of Missing Blood Alcohol Concentration (BAC) Values in FARS*. Washington, DC: National Highway Traffic Safety Administration; 1998.
 24. Subramanian R. *Transitioning to Multiple Imputation—A New Method to Estimate Missing Blood Alcohol Concentration (BAC) Values in FARS*. Washington, DC: Mathematical Analysis Division, National Center for Statistics and Analysis, National Highway Traffic Safety Administration; 2002. (DOT HS 809 403).
 25. Rubin D, Schafer J, Subramanian R. *Multiple Imputation of Missing Blood Alcohol Concentration (BAC) Values in FARS*. Washington, DC: National Highway Traffic Safety Administration; 1998. (DOT HS 808 816).
 26. Subramanian R, Utter D. Multiple imputation of missing blood alcohol concentration (BAC) values in FARS. Presented at the Federal Committee on Statistical Methodology Conference, Arlington, VA, November 17–19, 2003.
 27. Klebanoff MA, Cole SR. Use of multiple imputation in the epidemiologic literature. *Am J Epidemiol*. 2008;168(4): 355–357.
 28. Soderstrom CA, Dischinger PC, Kufera JA, et al. Crash culpability relative to age and sex for injured drivers using alcohol, marijuana or cocaine. *Annu Proc Assoc Adv Automot Med*. 2005;49:327–341.
 29. Federal Motor Carrier Safety Administration, Analysis Division. *Large Truck Crash Facts 2006*. Washington, DC: US Department of Transportation; 2008.