Effects of the .08 g/dL BAC Law on Fatal Crashes in the State of Maryland, USA

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Background

The State of Maryland, USA passed legislation effective October 1, 2001 reducing the *per se* illegal blood alcohol concentration (BAC) limit for drivers from .10 g/dL. to .08 g/dL. *Per se* laws differ from traditional laws against driving while intoxicated in that they make operating a motor vehicle at or above a proscribed BAC an offense "*per se*" (e.g., in and of itself). By not requiring proof of intoxication or impairment, per se laws ensure the certainty and celerity of punishment and reduce the burden on enforcement. As of October 1, 2003, 45 states plus the District of Columbia and Puerto Rico have adopted .08 g/dL per se laws.

The Community Preventive Services Task Force reviewed nine studies each of which evaluated .08 BAC laws in one or more of the 16 states that had implemented the law before January 1, 1998 (1, 2). Following implementation, the median decrease in fatal alcohol-related motor vehicle crashes was an estimated 7 percent. More recently, Voas et al. (3) studied the Illinois per se law that went into effect in June 1997 using time series methods to compare the change in the proportion of drinking drivers in fatal crashes to a similar change in 5 bordering states. Further corroborating the Task Force findings, this study reported that the proportion of drinking drivers involved in fatal crashes in Illinois was reduced after the effective date by a statistically significant 14 percent while in the 5 comparison states, the same proportion increased by 3 percent.

Objectives

The objective of the present research is to evaluate the effectiveness of Maryland's .08 law on the involvement of drivers with a positive BAC in fatal crashes.

Methodology

We compared changes in fatal motor vehicle crashes in Maryland after the law's effective date with concurrent and parallel changes in five neighboring states (Delaware, New Jersey, Pennsylvania, Virginia, and West Virginia) plus the District of Columbia. States were compared on changes in crash frequency and crash frequency ratios and not on population crash rates. Since the focus was on *changes* and not on rates, states with and without a .08 law could be legitimately included in comparisons as long as their per se limit remained unchanged during the study period. Among these six comparison jurisdictions, only the District of Columbia changed it's *per se* limit during the nine year study period between January 1, 1994 and December 31, 2002[1]. It lowered the limit to .08 g/dL on April 12, 1999. Of the five other comparison jurisdictions, Delaware had a .10 per se limit

[1] The study period was limited to 9 years, not 10, because the state of Virginia adopted a .08 per se limit on 1/1/1994. Including Virginia among the comparison states with a law change and just one year for the pre-intervention period was impractical. Rather than dropping Virginia from the comparison roster, the study period was shortened by one year.

and the rest of the states a .08 per se limit throughout the study period. Rather than excluding the District of Columbia from the study, we analyzed the effect of that law change as well. This was completed in a way that produced valid and comparable estimates for both law effects. Estimates for the effects of both laws are presented in this paper with an emphasis on Maryland.

Data relating to the role of alcohol in fatal crashes was extracted from the Fatal Analysis Reporting System (FARS) using imputed BAC. The final FARS files with multiple imputed BAC were summarized for a nine-year study period (January 1, 1994 – December 31, 2002) by month for Maryland and the six comparison sites. Records for crashes and persons involved in crashes and person-level variables were selected and summarized by state, year and month. Statistical methods included data preparation, modeling, model assessment, and summarizing estimates based on imputed data across ten multiply imputed data sets.

Count variables were log-transformed to stabilize variances and 1/6 was added to a variable if it had a zero count in at least one month in any of the states or the District of Columbia. Ratio variables were also defined on the log-scale for assessing change in a case series relative to its natural counterpart series. The numeral '1' was used to indicate that this variable is based on the first impute. Variables are defined similarly for imputes 2-10. For variables defined in terms of BACs, the steps involved in defining log-scale counts or ratios were repeatedly performed, once per impute. Taken together, the set of analysis variables provide a comprehensive picture of the involvement of alcohol in fatal crashes.

For the purpose of this study, the pattern of fatal motor vehicle crashes was described using a total of 29 statewide monthly measures for identifying characteristics most likely to be affected by a per se limit reduction. The list of characteristics included measures for driver involvement in fatal crashes by time of day (night[2]/day), type of crash (single vehicle/other) and by driver BAC level. Change in a characteristic after the effective date of the per se limit reduction was estimated by several time series methods. The monthly time series for each analysis variable was tested for evidence of a law effect using three methods. Method 1 separately estimated the effect in the law change states. With Method 1, Auto-Regressive time series models with an interruption term to represent law change effects were fitted to the Maryland series alone. Method 1 did not control for comparable changes elsewhere. Method 2 separately estimated the effects in the law change states from models that also included as predictor the equivalent analysis variable defined from pooled data for the comparison jurisdictions. With Method 2, the time series representing the same characteristics for all comparison areas pooled were included in each model. Method 2 controlled for the shared effects of any factor that might have affected the characteristic the same way in Maryland and the rest of the comparison areas. Method 3 estimated both law change effects from a combined model for all law change and comparison jurisdictions. All law effect specifications included similarly defined *interruption* terms and are directly comparable across the models. With Method 3, cross section time series were fitted to all states. These 'panel data' models accounted for separate state effects (both intercepts and state-specific auto-regression) plus shared seasonality. Methods 1-3 were also adopted to estimate the effects of a per se limit reduction in the District of Columbia that became effective on April 12, 1999 – the other states included in this study did not change their per se limits during the study period. Models 1 and 2 were estimated using the SAS ARIMA (Auto-Regressive Integrated Moving-Average) procedure, Model 3 was estimated using the SAS TSCSREG (Time

[2] Night was defined as the time period from 6:00 pm through 6:00 am.

Series Cross Section Regression) procedure (4). Multiply imputed driver BACs were used. NHTSA's multiple imputation procedures are described by Subramanian (5). For time series involving BACs, variances were adjusted for multiple imputation by applying methods developed by Rubin et al. (6).

Results

Table 1 reports the law effect estimates of 29 analysis variables for Maryland's .08 BAC law. There are separate estimates for law effects by Methods 1-3 (E1-E3) alongside the associated p-values (P1-P3) for assessing statistical significance.

As Table 1 shows, none of the three analyses detected a significant law effect for all crashes, alcohol-related (AR) crashes, persons killed, persons killed in AR-crashes, drivers killed, drivers killed in AR-crashes, drivers involved, drivers in AR-crashes, drivers in single vehicle (SV) crashes, drivers in SV crashes relative to drivers in non-SV crashes, drivers in AR SV crashes relative to drivers in non-AR SV crashes, drivers in SV night crashes, drivers in SV night crashes relative to drivers in SV day crashes, and for drivers in AR SV night crashes relative to drivers in non-AR SV night crashes. The model under Method 3 identified a statistically significant increase in the frequency of drivers in night crashes ($p = 0.046$, Method 3), however, since neither the change in drivers in night crashes relative to drivers in day crashes ($p = 0.27$, Method 3), nor the change in drivers in AR night crashes relative to drivers in non-AR night crashes ($p = 0.16$, Method 3), were statistically significant, the night crash frequency increase in Maryland was not attributable to the law change.

Table 1. Estimated Post-Law Change in Fatal Crashes in Maryland Using Three Methods: 1 – Time Series Based Estimates Within Maryland (E1 = Effect, P1 = P-Value); 2 – Time Series Based Estimates Relative to Adjacent States Pooled (E2, P2), and 3 – Cross-Sectional Time Series Based Estimates Relative to Individual Neighboring States (E3, P3). Data from Fatal Accident Reporting System for Maryland, Virginia, West Virginia, Delaware, New Jersey, Pennsylvania and the District of Columbia (1994 – 2002).

Obs	OUTCOME	E1	P1	E2	P2	E3	P3
1	L[1] (Total Crash Count)	0.065	0.288	0.024	0.620	0.057	0.180
2	LR[2] (AR[3] Crashes)	0.154	0.186	0.155	0.184	0.172	0.139
3	L (Persons Killed)	0.071	0.273	0.030	0.551	0.065	0.151
4	LR (Persons Killed AR)	0.146	0.220	0.147	0.218	0.167	0.157
5	L (Drivers Killed)	0.130	0.086	0.076	0.199	0.104	0.059
6	LR (Drivers Killed AR)	0.187	0.121	0.189	0.118	0.182	0.119
7	L (Driver Count)	0.086	0.202	0.051	0.347	0.042	0.397
8	LR (Driver Count AR)	0.179	0.096	0.176	0.098	0.172	0.098
9	L (Drivers in SV[4] Crashes)	0.072	0.446	0.004	0.958	0.066	0.352
10	LR (Drivers in SV Crashes)	0.011	0.916	-0.029	0.792	-0.064	0.543
11	LR (Drivers in AR SV Crashes)	0.203	0.128	0.211	0.120	0.224	0.103
12	L (Drivers in Night Crashes)	0.124	0.114	0.113	0.117	0.125	0.046
13	LR (Drivers in Night Crashes)	0.073	0.412	0.073	0.416	0.090	0.278
14	LR (Drivers in AR Night Crashes)	0.146	0.242	0.147	0.242	0.164	0.163
15	L (Drivers in SV Night Crashes)	0.102	0.340	0.036	0.698	0.072	0.401
16	LR (Drivers in SV Night Crashes)	0.043	0.687	0.014	0.896	-0.000	0.997
17	LR (Drivers in AR SV Night Crashes)	0.178	0.296	0.182	0.289	0.214	0.221
18	(Average Crash BAC)	0.505	0.261	0.509	0.260	0.462	0.303
19	(Average Driver BAC)	0.427	0.085	0.421	0.091	0.377	0.124
20	(Average Driver BAC SV Crashes)	0.574	0.191	0.585	0.188	0.580	0.212
21	(Average Driver BAC Night Crashes)	0.352	0.340	0.357	0.332	0.349	0.357
22	L (Drivers BAC = 0)	0.051	0.493	0.015	0.815	0.001	0.984
23	L (Drivers Any BAC)	0.209	0.073	0.189	0.070	0.203	0.040
24	L (Drivers BAC = 0 - .07)	0.061	0.403	0.029	0.639	0.017	0.766
25	L (Drivers BAC $\geq$ .08)	0.214	0.063	0.186	0.071	0.200	0.048
26	L (Drivers BAC = 0 - .09)	0.060	0.411	0.025	0.671	0.014	0.797
27	L (Drivers BAC > .10)	0.246	0.049	0.220	0.053	0.217	0.050
28	LR (Drivers BAC > =.08) / (Drivers BAC < .08)	0.171	0.097	0.167	0.104	0.155	0.122
29	LR (Drivers BAC > =.10) / (Drivers BAC < .10)	0.211	0.059	0.208	0.064	0.185	0.091

[1] Log
[2] Log Reciprocal
[3] Alcohol-Related
[4] Single Vehicle

Discussion

The pattern of change in drivers in crashes by BAC is complicated. To begin with, there was a non-significant increase in the fatal crash involvement of drivers with a zero BAC, and a statistically significant increase in drivers with any positive BAC (p = 0.04, Method 3), but the increase in drivers with a positive BAC was not statistically significant relative to the increase in drivers with a zero BAC (p = 0.098, Method 3). Also, there were non-significant increases in the crash involvement of drivers with BACs below .08 g/dL and with BACs below 0.1 g/dL, and statistically significant increases in the crash involvement of drivers with BACs at or above .08 g/dL (p = 0.048, Method 3) and with BACs at or above

0.1 g/dL (p = 0.05, Method 3). However, neither of the high-BAC to low-BAC ratios exhibited a statistically significant increase with p = 0.12 for the comparison with the threshold at .08 g/dL and p = .091 for the comparison at 0.1 g/dL. Change in average BAC was not statistically significant at the conventional 95% confidence level for any of the following: all crashes, drivers in crashes, drivers in single vehicle crashes, and drivers in night crashes.

Taken together, this comprehensive analysis of fatality data for 9 years that included only a 15 month follow-up period provided no evidence that Maryland's newly adopted .08 g/dL per se limit caused any change in the pattern of fatal motor vehicle crashes in that state.

Similar law effect estimates for the same set of analysis variables as used in Maryland were run for the District of Columbia. Neither the change in alcohol-related (AR) crashes relative to non-AR crashes (p = 0.65, Method 2), nor the change in persons killed in an AR crash relative to persons killed in a non-AR crash (p = 0.65, Method 2) were statistically significant (data not shown). In addition, none of the other change parameters for AR crashes were statistically significant. Overall, analysis of fatality data for 9 years that included a 42 month follow-up period provided no evidence that the newly adopted .08 g/dL per se limit in the District of Columbia was associated with any change in the pattern of fatal motor vehicle crashes in that jurisdiction.

Model fit diagnostics (data not shown) were run for both the Maryland and the District of Columbia models. Essentially all models for which the results were reported met their respective criteria for valid inference. No model-validity test was computed for the cross-sectional time series models used to derive the third set of estimates presented in Table 1, except for R-squares which were almost universally high, indicating that most models had strong explanatory power.

Summary and Conclusions

We found no statistical evidence that reducing the per se BAC limit for drivers from .10 g/dL to .08 g/dL had a measurable effect on the pattern of alcohol-related fatal motor vehicle crashes in Maryland during a post-law change period of 15 months. Similarly, there was no evidence that a parallel law change in the District of Columbia had a measurable effect on the pattern of alcohol-related fatal motor vehicle crashes in the District of Columbia during a post-law change period of 42 months. The most important limitation of the present analysis is that Maryland's post-law change period is only about 15 months, too short to generate an adequate sample size for definitive conclusions. In contrast, the nine evaluations summarized by the Community Preventive Services Task Force estimated a median post-law change of 7% in alcohol-related motor vehicle fatalities with a median post-law follow-up period of 5 years. The major limitation for the analyses for the District of Columbia data is that since the District of Columbia has a relatively small population and urban traffic patterns, the total number of fatal motor vehicle crashes is relatively small.

Acknowledgements

Funding for this research has been provided in part by Grant R01 AA11897 from the National Institute on Alcohol Abuse and Alcoholism, and under contract with the Driver Safety Research Office of the Maryland Motor Vehicle Administration and the Maryland Highway Safety Office of the State Highway Administration. The research team would like to thank Dr. Robert Raleigh, Jack Joyce and Nelson Gretsinger of the Maryland Motor Vehicle Administration for their contributions to the research effort.

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