Short and Long-Term Effects of Drinking Driving Laws: An Evaluation of Canada's Per Se Law

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Background

Alcohol-related traffic fatalities across North America have declined over the last 25 years[1,2]. Perhaps the biggest contributor to the decline in alcohol-related crashes has been public policy[3]. On December 1st 1969, Canada introduced its per se law, criminalizing driving with a BAC over 80 mgs%, making it mandatory for drivers to provide a breath sample when requested by the police and making it a crime to refuse to provide a breath sample. Canada's law was modeled on the 1967 British Road Safety Act, which in turn was modeled on Scandinavian per se laws.

Studies of the short-term impact of policies have revealed that levels of impaired driving drop, often dramatically, after a new law is enacted but following the initial success of the policy, rates of impaired driving begin to regress to pre-law levels[4-6]. Carr et al.[7] found a 6.3% decrease in fatal accidents in the year following the enactment of Canada's per se law and Chambers et al.[8] found fatalities decreased by 8.2% in the 15 months following the law; however, both studies found road fatalities in Canada increased to pre-1969 levels and higher by the end of 1971 or beginning of 1972. One reason for this may be that as time passed, drivers began to perceive that their chances of being caught and charged with impaired driving were not substantially different. This may represent a gap between the enactment of legislation and the emergence of resources that allow the police and/or prosecutors to properly enforce the new legislation[9,10].

Studies on the impact of impaired driving legislation over a longer period suggest that impaired driving laws can have enduring effects in reducing the rate of impaired driver collisions and fatalities[11,12]. There are a number of reasons to study the long-term effectiveness of impaired driving policy. First, there is greater confidence in examining the long-term impact of behaviour, which is more stable compared to the minor peaks and dips evident in short-term evaluations. Second, there is often a lag between the enactment of laws and subsequent behaviour change, possibly due to a lack of infrastructure and resources to enforce the new law[13]. Finally, legislation may induce gradual changes in behaviour by influencing social norms and attitudes towards impaired driving[14], an indirect, yet important function of the law. Snortum and Riley[15] also suggest that exogenous influences, such as rainfall, alcohol consumption, and traffic safety, have not always been considered when looking at the impact of legislative change. Votey[16] and Phillips et al.[12] found that when fatalities were examined over the long run, controlling for exogenous influences, the 1967 British Road Safety Act produced a small but enduring reduction in traffic fatalities, contrary to initial findings[4].

Objective

We aim to evaluate whether Canada's 1969 per se law produced an enduring effect on drinking driver fatalities controlling for a number of factors, such as alcohol consumption, based on time series analyses of Ontario data from 1962 to 1996.

Methodology

Our primary outcome measures are fatally injured drivers who had been drinking (n=15,376, annually=452, SD=125) and fatally injured drivers who had not been drinking (n=32,197, annually=947, SD=225) in Ontario, between 1962 and 1996. The rate of non-drinking driver fatalities is used as a control series. Driver fatality data were obtained from Ministry of Transportation of Ontario annual reports and aggregated by year. Data include drivers of motor vehicles (i.e. cars, motorcycles, minivans, pick-up trucks, SUVs), and exclude drivers of recreational off-road vehicles, motorized snow vehicles, farm tractors, construction equipment, trains, streetcars, bicycles, and other non-motor vehicles or unknown vehicle types. Those who had been drinking (including those who are impaired) comprise the drinking driver group and non-drinking drivers are those whose condition is normal (i.e. no alcohol, drugs, or medical conditions are recorded). A large portion of assignments to the drinking driver group are based on coroners' reports (including a BAC test), and the remainder are based on police reports.

The main independent measure is Canada's per se law, introduced Dec. 1, 1969. This law is modelled as a step intervention (binary coded zero for 1962-69, one for 1970-96). We also include six control measures that might confound the fatality data. Two are interruption measures: Ontario's mandatory seatbelt legislation introduced in 1976, and the emergence of MADD Canada, which began in Ontario in 1982 (originally named PRIDE). Interruption control measures are modelled as step interventions (binary coded as zero prior to the interruption and one afterwards). Four trend measures are used as control measures (annual Ontario data from Canadian government statistics reports, 1962-96): per capita alcohol consumption, number of vehicles registered per person, annual precipitation, and the annual unemployment rate in Ontario.

Analyses of time series data is a highly feasible approach for assessing the aggregate consequences of legislative change[17]. We employ an interrupted time series analysis, with ARIMA (auto-regressive integrated moving average) modelling, a methodological approach designed for use with trend data[18,19], to explore changes in driver fatalities for the period 1962-96. Time series analysis offers a statistical procedure with high levels of internal validity approaching that of randomized trials[20]. Also, time series approaches are good at isolating the critical effects of an intervention and for ruling out a number of rival hypotheses, such as changes due to instability of data, seasonal variation or to long-range trends already occurring prior to the intervention[21].

We use semi-logarithm models estimated on differenced Ontario data for the drinking driver fatalities and non-drinking driver fatalities models. The drinking and non-drinking series of drivers for Ontario are log-transformed, while all other explanatory measures are un-logged. All models employed measures that were differenced, i.e., yearly changes were used instead of the raw data. We interpret results by converting fatality coefficients from their semi-log form into estimated attributable fractions[22], thus providing the percentage increase or decrease in fatalities linked to each explanatory measure.

Results and Analysis

Between 1962 and 1996 drinking driver fatalities and per capita alcohol consumption show a slight increase, peaking in 1972 and 1979, respectively, followed by a sustained decrease (see Figure 1).

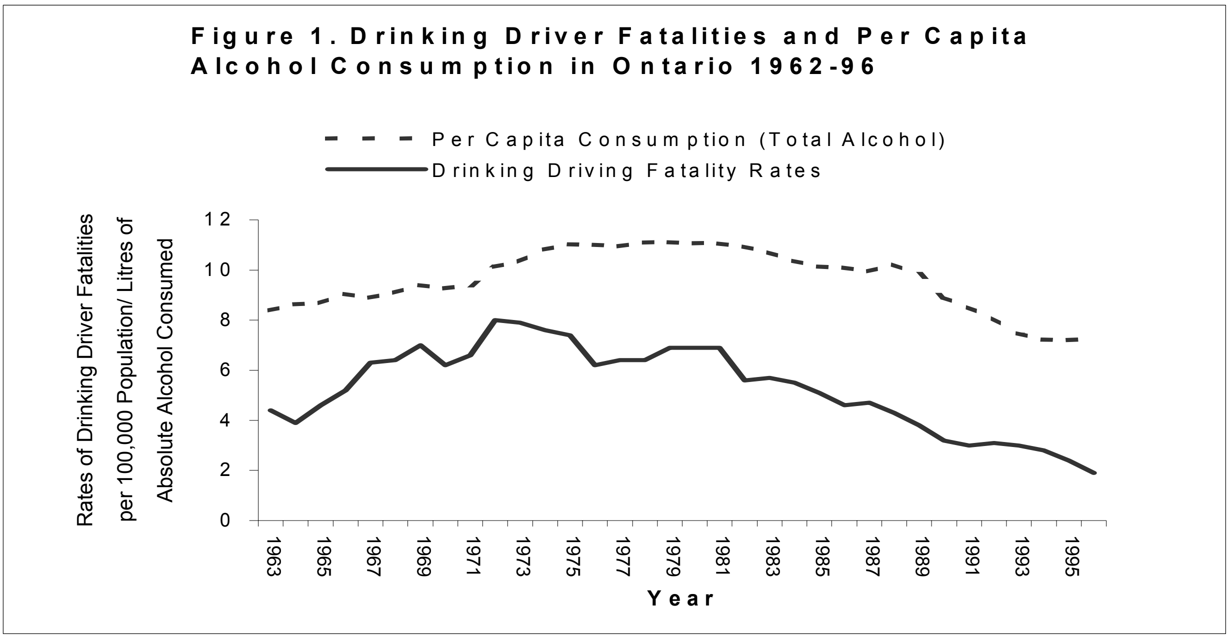

Table 1 presents results of the per se law, the founding of MADD Canada, Ontario's mandatory seatbelt law, per capita alcohol consumption, the unemployment rate, the number of vehicles registered per person, and precipitation rates, predicting drinking driver fatalities and non-drinking driver fatalities for the period 1962 to 1996. We estimate four models. Model 1 includes all explanatory measures in the analysis, while models 2 thru 4 look at various subsets of measures. Among trend measures, only alcohol consumption produces a significant effect on drinking driver fatalities. A one-litre increase in per capita alcohol consumption leads to an increase in drinking driver fatalities ranging from 8% (model 1 & 3) to 14% (model 2). The largest effects are linked to the interruption measures. The introduction of the per se law leads to a significant decrease in drinking driver fatalities. Based on the estimated attributable fraction for the intervention measure, the per se law is associated with an 18% reduction in the proportion of drinking driver fatalities in Ontario between 1969 and 1996.

Similarly, the formation of MADD produces a decrease in drinking driver fatalities in Ontario in the period 1982 to 1996, ranging from 19% (model 1) to 23% (model 4). Interestingly, Ontario's mandatory seatbelt law introduced in 1976 did not significantly influence drinking driver fatality rates, with the exception of model 2, which includes only MADD and alcohol consumption as additional explanatory measures. When the per se law is modelled alongside the Ontario mandatory seatbelt law, the latter becomes non-significant. Tests for normality of residuals indicates that all four models are satisfactory, while the noise parameters estimated for each model are below unity and a simple and reasonable structure is preserved. The overall fit of each model ranged from an Adjusted R-Squared of 0.37 (model 2) to 0.50 (model 3).

Comparing the time series analyses for non-drinking driver fatalities to the models predicting drinking driver fatalities, we observe two key differences. First, while alcohol consumption positively predicts drinking driver fatalities, it is not significantly associated with non-drinking driver fatalities. The other trend measures remain non-significant in predicting non-drinking driver fatalities. Second, while the per se law has a strong, negative association to drinking driver fatalities, it is not significantly associated with non-drinking driver fatalities in any of the models. Conversely, Ontario's mandatory seatbelt law, which is unrelated to drinking driver fatalities, produces a significant decrease in non-drinking driver fatalities of 15% during the period 1976 to 1996.

Table 1. Time series analyses of *drinking* and *non-drinking* driver fatalities in Ontario, 1962-96

	Model 1 Effect (SE)	Model 2 Effect (SE)	Model 3 Effect (SE)	Model 4 Effect (SE)
Predicting drinking driver fatalities				
Step Interruption Effects				
per se law	-0.21 [b] (0.07)		-0.20 [a] (0.06)	-0.20 [a] (0.06)
MADD Canada	-0.21 [b] (0.09)	-0.23 [a] (0.07)	-0.25 [a] (0.05)	-0.26 [a] (0.05)
Ontario Mandatory Seatbelt Law	-0.08 (0.07)	-0.14 [c] (0.07)	-0.07 (0.06)	
Trend Measures				
Alcohol Consumption	0.08 [c] (0.04)	0.13 [a] (0.05)	0.08 [b] (0.04)	0.09 [b] (0.04)
Unemployment Rate	-0.01 (0.02)			
Vehicles Registered	-0.84 (1.50)			
Precipitation Rates	-0.00 (0.00)			
Noise Parameters				
MA(1)	0.57 [a] (0.12)	0.60 [a] (0.10)	0.55 [a] (0.13)	0.48 [a] (0.13)
MA(2)	0.81 [a] (0.15)	0.61 [a] (0.13)	0.77 [a] (0.13)	0.81 [a] (0.11)
Residual Tests				
Jarque-Bera Normality test	2.20 p>0.33	0.59 p>0.74	0.99 p>0.61	0.70 p>0.70
Box-Ljung Q (lag 7)	4.41 p>0.62	2.51 p>0.87	4.89 p>0.56	3.69 p>0.72
Adjusted R-Squared	0.45	0.37	0.50	0.49
Predicting non-drinking driver fatalities				
Step Interruption Effects				
per se law	-0.01 (0.08)		-0.04 (0.08)	-0.01 (0.08)
MADD Canada	-0.20 [b] (0.09)	-0.24 [a] (0.06)	-0.24 [a] (0.06)	-0.26 [a] (0.07)
Ontario Mandatory Seatbelt Law	-0.16 [b] (0.09)	-0.16 [b] (0.07)	-0.16 [b] (0.07)	
Trend Measures				
Alcohol Consumption	0.05 (0.04)	0.03 (0.04)	0.04 (0.04)	0.04 (0.04)
Unemployment Rate	-0.02 (0.01)			
Vehicles Registered	-1.41 (1.09)			
Precipitation Rates	0.00 (0.00)			
Noise Parameters				
AR(1)	-0.50 [b] (0.19)			
MA(3)		-0.37 [b] (0.14)	-0.35 [b] (0.14)	-0.49 [a] (0.14)
MA(4)		0.59 [a] (0.13)	0.61 [a] (0.13)	0.51 [a] (0.10)
Residual Tests				
Jarque-Bera Normality test	1.19 p>0.55	1.75 p>0.42	1.89 p>0.39	1.82 p>0.40
Box-Ljung Q (lag 7)	5.28 p>0.63	5.99 p>0.43	6.10 p>0.41	3.93 p>0.69
Adjusted R-Squared	0.34	0.45	0.43	0.34

[a] p. <0.01 [b] p. <0.05 [c] p. <0.10

The emergence of MADD was the only measure significantly associated with both drinking and non-drinking driver fatalities. MADD led to a decrease in non-drinking driver fatalities in Ontario between 1982 and 1996, ranging from 18% (model 1) to 23% (model 4). Significant autoregressive and seasonal moving average parameters are observed and retained in the model. The residuals tests indicate that all four models are satisfactory, while noise parameters estimated for each model were below unity and a simple and reasonable structure is preserved. The overall fit of the models ranged from an Adjusted R-squared of 0.34 in models 1 and 4, to Adjusted R-squared of 0.45 in model 2.

Discussion

This study confirms that the 1969 per se law was associated with a decline in drinking driver fatalities. Controlling for other explanatory measures, drinking driver fatalities decreased approximately 18% in the period after the law was introduced compared to before. This finding is consistent with previous research on per se laws[2,23,24]. While early research found only short-term reductions in fatalities, we observe an enduring reduction in drinking driving fatalities in the 27 years following the enactment of the law. The per se law, however, had no measurable effect on non-drinking driver fatalities, and was dwarfed by the robust effects of the emergence of MADD and enactment of Ontario's mandatory seatbelt law. These data suggest that Canada's per se law is an effective deterrent for drinking driving and not for non-drinking fatal crashes.

Ontario's seatbelt law had no influence on drinking driver fatalities yet resulted in a significant decline in non-drinking driver fatalities. These data contradict previous studies[2], but was consistent with Sen's[25] finding that enactment of mandatory seatbelt legislation was significantly associated with a reduction in non-impaired fatalities. One explanation for this finding may lie in the clustering of risky behaviours in individuals. Whether drinking drivers fail to wear seatbelts due to the intoxication or simply as a product of risk-taking personality is unclear.

The emergence of MADD Canada was associated with decreases in both drinking and non-drinking driver fatalities in Ontario. In fact, MADD had a stronger effect than the per se law on drinking driver fatalities. While the current findings do not capture the political activity of MADD in shaping the policy process, the timing of the emergence of MADD was linked to aggregate declines in driver fatalities in Ontario.

Conclusion

This study suggests that the per se law helped to transform public thinking about impaired driving in Canada. There is evidence in other locales that the initial effectiveness of formal legal sanctions are eventually replaced or reinforced by informal sanctions[26]. This study identifies additional influences, such as per capita alcohol consumption, grassroots organizations, and other legislative activity, that shape driver fatality rates. More importantly, this research adds to the policy literature on drinking and driving by suggesting that impaired driving legislation can produce an enduring, long-term effect on fatalities, and is not solely limited to short-term, pulse effects.

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