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Road safety impact of extended drinking hours in Ontario

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Abstract

Purpose: On 1 May 1996, Ontario, Canada amended the Liquor Licence Act to extend the hours of alcohol sales and service in licensed establishments from 1 to 2 a.m. The purpose of this study was to evaluate the road safety impact of extended drinking hours in Ontario.
Method: A quasi-experimental design using interrupted time series with a nonequivalent no-intervention control group was used to assess changes. The analyzed data sets are total and alcohol-related, monthly, traffic fatalities for Ontario, for the 11–12 p.m., 12–1 a.m., 1–2 a.m. and 2–3 a.m. time windows, for Sunday through Wednesday nights and for Thursday through Saturday nights, for 4 years pre- and 3 years post-policy change, compared to neighbouring regions of New York and Michigan.
Results: The blood alcohol concentration positive driver fatality trends reflected downward trends for Sunday–Wednesday 12–2 a.m. and Thursday–Saturday 1–2 a.m. for Ontario and downward trends for Thursday–Saturday 12–1 a.m. and 2–3 a.m. for New York and Michigan after the extended drinking hour policy change. Ontario total fatality data showed similar trends to the Ontario blood alcohol positive trends.
Conclusions: The multiple datasets converge in suggesting little impact on BAC positive fatalities with extension of the closing hours. These observations are consistent with other studies of small changes in alcohol availability.
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Keywords: Drinking hours; Alcohol control policy; Collisions; Fatalities

1. Introduction

Over the past two decades, the number of deaths and injuries related to impaired driving has decreased significantly in Canada and the United States as well as in other industrialized nations (Beirness et al., 1994; Stewart et al., 1995; Sweedler, 2002). The progress that has been made to reduce impaired driving, however, is being challenged by a political and economic mood against governmental control and regulation (Anglin et al., 2002; Gliksman et al., 1995; Stewart, 1999). Moves to privatization, de-regulation, liberalization and fewer controls have been evident internationally (Vingilis et al., 1998). One example of liberalization occurred in the province of Ontario with the extension of drinking hours in licensed establishments. On 1 May 1996, Ontario, Canada amended the Liquor Licence Act to extend the closing hours for alcohol sales and service in licensed establishments from 1 to 2 a.m. This amendment provided an excellent natural experiment to evaluate an important alcohol policy.

Research on the effects of changes to hours and days of sale on traffic safety measures is limited. A series of studies on the effects of increased hours of sale of alcoholic beverages in various cities and states of Australia, reported by Smith (1978, 1986, 1987, 1988a,b,c, 1990), found significant increases in either fatal or injury-producing crashes in the years in which alcohol became more available in comparison with

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previous years, control times periods or control areas where no changes were introduced. More recently evaluations of the public health and safety impact of extended trading permit hours were conducted in Perth, Australia (Chikritzhs et al., 1997). Levels of monthly assaults more than doubled in hotels that had received extended hours permits compared to no changes in hotels with normal hours. However, no significant increases in road crashes were found related to the extended trading permits.

Only one preliminary assessment has been conducted of Ontario's new amendment. In August 1996, 4 months after the law came into effect, the former Liquor Licence Board of Ontario (LLBO) (now amalgamated into the Alcohol and Gaming Commission of Ontario) surveyed their inspectors throughout Ontario to determine extent and number of violations against the new regulations on cease sale of service at 2 a.m. complaints regarding after-hours sale and service since extension, increases in police services (number of after-hours violations since extension), the operating hours in district, and perceptions of problems, significant differences in operating style, violations, etc. (Bolton, 1996). The results of the survey were consistent across the province. No major increases in problems with the extended hours were documented. In fact, in the period from 1 May 1995 to 1 August 1995, when the 1 a.m. closing was still in effect, police services reported to the Board 15 offences of sale and service of liquor outside prescribed hours (SSLOPH) and 38 violations of fail to remove signs of sale and service (FRSSS) by 1:45 a.m. However, during this same period in 1996, only three breaches of SSLOPH and five offences of FRSSS by 2:45 a.m. were reported, which constituted a reduction from previous year of 80% and 88%, respectively (Bolton, 1996). Perceptions of inspectors of changes in drinking patterns were that some establishments had increased sales while other establishments stated sales were the same because patrons were arriving and leaving later. Inspectors also indicated that many licensed establishments in their local areas that had historically stayed open until 1 a.m. had extended their drinking hours to 2 a.m. on Thursday to Saturday nights, but still maintained their 1 a.m. closing on weekday nights of Sunday to Wednesday. However, the research design and methodological problems of this study preclude conclusions being drawn about the impact of the new regulations.

The purpose of this study was to conduct a comprehensive evaluation of the road safety impact of the extended drinking hours regulation in Ontario. Intermediate outcomes included analyses of volume of sales of alcoholic beverages in Ontario in order to provide information on overall trends in purchase of alcohol in Ontario during the evaluation time period. The criterion outcome measure was motor vehicle fatalities. A quasi-experimental design, using interrupted time series with a nonequivalent no-intervention control group, was used to assess changes in total motor vehicle fatalities and motor vehicle fatalities with a positive blood alcohol concentration (BAC) with the introduction of the extended drinking hours regulations.

2. Methods

2.1. Volume of sales of alcoholic beverages

In Ontario, the purchase of any alcohol (wine, beer and spirits) used in licensed establishments or for "personal" consumption is through government regulated monopoly stores with the exceptions of duty free and possible contraband purchases (Girling, 1994). Additionally, alcohol prices are government controlled so the prices of different brands remain the same throughout the province. Data were available on yearly sales in litres to licensees and to retail for domestic and imported wines, beers and spirits for Ontario for the years 1 April 1989 to 31 March 1999 (Statistics Canada, 2000).

2.2. Motor vehicle fatalities

The focus of this study was on total and BAC positive fatalities during the 11 p.m.–4 a.m. time windows. Additionally, these data were disaggregated by day of week. A post policy survey by the LLBO found that licensed establishments in smaller communities often maintained their 1 a.m. closing time for Sunday through Wednesday nights because of lack of sufficient business, but kept open until 2 a.m. on Thursday through Saturday nights (Bolton, 1996). Thus, the data were collapsed into two weekday groups: (1) Sunday–Wednesday nights (Sunday 11 p.m. to Thursday 4 a.m.); and (2) Thursday–Saturday nights (Thursday 11 p.m. to Sunday 4 a.m.). Moreover, prior to the extended hours policy change, two peaks for late night BAC positive motor vehicle fatalities occurred between 11 p.m.–12 a.m. and 1–2 a.m. in Ontario (Ministry of Transportation of Ontario (MTO), 1996). In order to examine changes in trends in relation to the extended drinking hours policy, the criterion data sets for the evaluation are monthly motor vehicle casualties for the 11:00–11:59 p.m. (denoted as 11 p.m.–12 a.m.), 12:00–12:59 a.m. (12–1:00 a.m.), 1.00–1:59 a.m. (1–2 a.m.), 2:00–2:59 a.m. (2–3 a.m.), and 3:00–3:59 a.m. (3–4 a.m.) time windows, by weekday grouping (Sunday–Wednesday versus Thursday–Saturday) for 4 years pre- and 3 years post policy change in Ontario. Two comparison groups were used. Ontario BAC positive fatalities were compared to Ontario total fatalities. Additionally, motor vehicle casualties in Ontario were compared to New York and Michigan, two neighbouring American states. The neighbouring US states of New York and Michigan were chosen as comparator regions to control for climatic and history effects (Cook and Campbell, 1979). Adjacent Canadian provinces either did not have sufficient fatalities (Manitoba) or had introduced a variety of drinking-driving prevention policies that may have confounded the data (Québec). Measures of alcohol consumption, relative importance of alcohol by sector and per capita consumption for Canada and the United States indicate very similar patterns and trends (Williams et al., 1994). In addition, the trends for both the United States

and Canada have been showing a downward trend in per capita consumption and alcohol-related health and safety consequences since the 1980s (Anglin et al., 1995; Mann et al., 1991; Produktschap voor Gedistilleerde Dranken, 1996). Similarly, motor vehicle fatality and drinking-driving fatality data are comparable despite the differences in data gathering and definitions (Ministry of Transportation of Ontario (MTO), 1996; NHTSA, 1996). Furthermore, despite the somewhat different classifications and rates of testing, both Ontario and the U.S. have very similar distributions of BAC levels among drinking-drivers (NHTSA, 1996; Mayhew et al., 1996). Additionally, 70.44% of Ontarians are licensed drivers compared to 67.68% of Americans. Licensed establishments close at 2 a.m. in Michigan while in New York they range between 1 a.m. and 4 a.m., depending on the county.

Two datasets used were: (1) Traffic Injury Research Foundation (TIRF)[1] and (2) the US Fatal Analysis Reporting System (FARS) databases. The TIRF Fatality Database is a comprehensive source of objective data on alcohol use among persons fatally injured in motor vehicle crashes occurring on and off the highways (e.g. snowmobiles, boats, pedestrians). It includes information on characteristics of drivers, passengers, and pedestrians; details of the crash (e.g. type of collision, date, time); and type of vehicle(s) involved. Objective information on the presence and quantity of alcohol (concentrations detected by chemical tests on blood, urine or other body fluids) as well as information needed to interpret the results of chemical tests – such as time of death – is included in the TIRF database. Two sources of information provide data for most case files: (1) police-reported data on fatal motor vehicle collisions and (2) files in the offices of coroners and medical examiners. Because of the high BAC testing rates (e.g. 82.2% in 1996) for Ontario drivers fatally injured within 6 h of collision, this database provided the most sensitive measure of changes in alcohol-related fatalities. In 1996, 37% of fatally injured drivers were BAC positive and of those 30% were over Canada's legal limit of .08% (Mayhew et al., 1996).

The FARS database on police-reported fatal motor vehicle collisions is gathered from states' source documents. In order to be included in FARS, a crash must involve a motor vehicle travelling on a road or highway customarily open to the public and result in the death of a person (either vehicle occupant or non-motorist) within 30 days of the crash. Nationwide in 1996 a total of 16,689 fatally injured drivers had BAC test results out of 24,456, or 68.2%. Testing rates for Michigan and New York, the two comparison states, were 71.2% and 47.8%, respectively. In Michigan for 1996, 1505 drivers died of whom 41% were BAC positive and 32% were over .10%, while in New York, 1564 drivers died of whom 34% were BAC positive and 24% were over .10%.

[1] The TIRF Fatality Database is funded by Transport Canada and the Canadian Council of Motor Transport Administrators.

2.3. Statistical time series analyses

The data from TIRF and FARS were aggregated into monthly counts according to hour (five groupings between 11 p.m. and 3:59 a.m.) and "weekgroup" (Sunday–Wednesday (S) and Thursday–Saturday (T)), generating ten time series for each data set. Following exploratory analyses, the simple step intervention model (Box and Tiao, 1976) was fitted to test statistically for the presence of shifts in the level of the time series. This model may be written,

$$z_t = c + g(x_t) + I_t + N_t$$

where z_t denotes the observed time series value corresponding to the tth observation number, c is the constant term, $g(x_t)$ is a term involving a linear function or a transfer-function of one or more covariate time series, I_t represents the intervention term and N_t represents the error or disturbance term assumed to follow an ARIMA or SARIMA time series model. For the simple step intervention model, we may write,

$$I_t = \omega \cdot S_t^{(T)}$$

where

$$S_t^{(T)} = \begin{matrix} 0 & t \leq T \\ 1 & t \geq T \end{matrix}$$

and T is the time the effect of the intervention starts which in this case is the observation number corresponding to May 1996, ω is the parameter which determines the effect of the intervention. In fitting this model, a suitable model for the noise term can be identified by examining the pre-intervention series or by following a two-stage identification process (Hipel and McLeod, 1994). In the two-stage process, the model is initially assumed to be white noise, or in other words, N_t, is assumed to be normal distributed and statistically independent. After the model is fit, plots of the residual autocorrelation function are examined to check for possible autocorrelation. If autocorrelation is found then a suitable model is determined for N_t, and the model is refit using maximum likelihood estimation.

In most cases, our analysis identified the term N_t as white noise so linear regression analysis could be used. For the TIRF datasets it was found that the time series of monthly fatalities, when disaggregated into hour and weekgroups, consisted almost entirely of very small integer values, usually zeros, ones and twos. In this case the normality assumption is not satisfied and a generalized linear model (McCullagh and Nelder, 1989) was used. Since it was found that there was no significant autocorrelation present in the TIRF and FARS time series, models assuming independence can be used.

The generalized linear model, formulated for a simple step intervention, is comprised of three components:

(a) the probability function, $f(z_t, \mu_t, \theta)$, where μ_t is the expected value of z_t and θ represents the distributional parameter or parameters;
(b) the linear predictor, $\eta_t = c + \omega \cdot S_t^{(T)}$;

(c) the link function, $\eta_t = l(\mu_t)$.

In some cases the data were adequately represented by the Poisson distribution while in other cases it was necessary to use a negative binomial regression (Venables and Ripley, 2002) due to over-dispersion in the data. The log link function was used. Poisson and negative binomial regression were fit using exact maximum likelihood estimation (Currie, 1995). In general, we found that these models agreed very well with the results obtained by fitting the normal linear regression model as might be expected from the robustness result of Hjort (1994).

3. Results

3.1. Volume of sales of alcoholic beverages

The volume of sales in thousands of litres for beer, wine and spirits and per capita 15 years and over for Ontario between 1989 and 1999 were subjected to time series analyses. The trends indicate that the consumption of beer has decreased between 1994 and 1998, while the consumption of wine and spirits decreased in the early 1990s and increased in the late 1990s.

3.2. Motor vehicle fatalities

TIRF data on driver fatalities (347 in total) were available for Ontario from 1 January 1992 to 31 December 1998 and were aggregated to a monthly level for a total of 84 consecutive observations. The ten time series were created from the TIRF Fatality Database. Separate analyses were conducted for total driver fatalities and BAC positive driver fatalities. For the TIRF data, the BAC variable was missing in 2.48% of the records. The focus of the analyses was on determining whether a change occurred after the introduction of the extended drinking hours, effective 1 May 1996, the 53rd observation.

The FARS time series comprised the monthly number of driver fatalities (3205 in total) for 1 May 1992 to 31 December 1999 for a total of 91 consecutive observations. The ten time series, corresponding to those constructed from the TIRF data, were created. Separate analyses were conducted for total driver fatalities and BAC positive driver fatalities. For the FARS data, the BAC variable was missing in 38% of the records. The focus of the analyses was on whether a change occurred concurrent with the introduction of the extended drinking hours in Ontario, effective 1 May 1996, the 49th observation.

The total and BAC positive TIRF and FARS driver fatality data were aggregated over the 11 p.m.–4 a.m. time periods to determine whether there had been overall increases in total and/or BAC positive driver fatalities over the evening drinking hours in relation to the introduction of the extended drinking hours policy. The results of the intervention analysis indicated no significant changes for Sunday–Wednesday (S) and Thursday–Saturday (T) groups for total driver fatalities for both TIRF and FARS data. For BAC positive monthly pre-post driver fatalities shown in Fig. 1, downward trends were observed for Ontario TIRF data for both Sunday–Wednesday (S) ($p = .07$) and Thursday–Saturday (T) ($p = .06$) groups, while a significant downward trend was observed for the control group FARS data for Thursday–Saturday ($p = .00$).

Data were disaggregated to examine changes for the individual hours between 11 p.m. and 4 a.m. to determine whether the downward trends observed in the aggregate data displayed in Fig. 1 were due to shifts in peak late evening fatalities from the 1–2 a.m. to the 2–3 a.m. time windows commensurate with the introduction of the extended drinking hours or to changes during other time windows. Fig. 2 shows the pre-post time series and trend lines for Ontario BAC positive driver fatalities, Ontario total driver fatalities and New York–Michigan BAC positive driver fatalities for Sunday–Wednesday nights[2] 1–1:59 a.m. (S1) and 2–2:59 a.m. (S2), and for Thursday–Saturday 1–1:59 a.m. (T1) and 2–2:59 a.m. (T2). For Sunday–Wednesday significant downward trends occurred for 1–2 a.m. for BAC positive ($p = .01$) and for total driver fatalities ($p = .006$) in Ontario, while no changes occurred for the FARS data. For Thursday–Saturday no significant trends were found for Ontario BAC positive and total driver fatalities while New York–Michigan BAC positive driver fatalities showed a significant downward trend ($p = .001$) for the 2–3 a.m. time window. The only other significant trends (not shown in the figures) were decreases in BAC positive driver fatalities which occurred in Ontario for Sunday–Wednesday 12–1 a.m. ($p = .024$), and in New York–Michigan for Thursday–Saturday 12–1 a.m. ($p = .03$).

To control for possible overall downward trends in Ontario collision rates, the BAC positive TIRF driver fatality data were re-analyzed using the TIRF BAC negative driver fatality data as a covariate. The results did not differ from the analyses without the covariate.

To determine whether there was a temporal shift in BAC positive driver fatalities, BAC positive TIRF data were collapsed over the pre- and post-amendment time periods for the different hours and Sunday–Wednesday and Thursday–Saturday weekgroups. Fig. 3 indicates that for the Sunday–Wednesday time period the peaks for BAC positive driver fatalities occurred between 12 and 2 a.m. pre-amendment while the peaks occurred between 2 and 4 a.m. post-amendment. However, the distribution is different for the Thursday–Saturday time periods. Prior to the amendment the peaks of BAC positive driver fatalities occur at 11

[2] Sunday through Wednesday and Thursday through Saturday nights refer to the hours 11 p.m. to 4 a.m., and thus Sunday night after midnight actually would be Monday morning 12 a.m. to 4 a.m. For consistency, the Sunday–Wednesday and Thursday–Saturday is used to connote the hour before midnight and the hours after midnight of the next day.

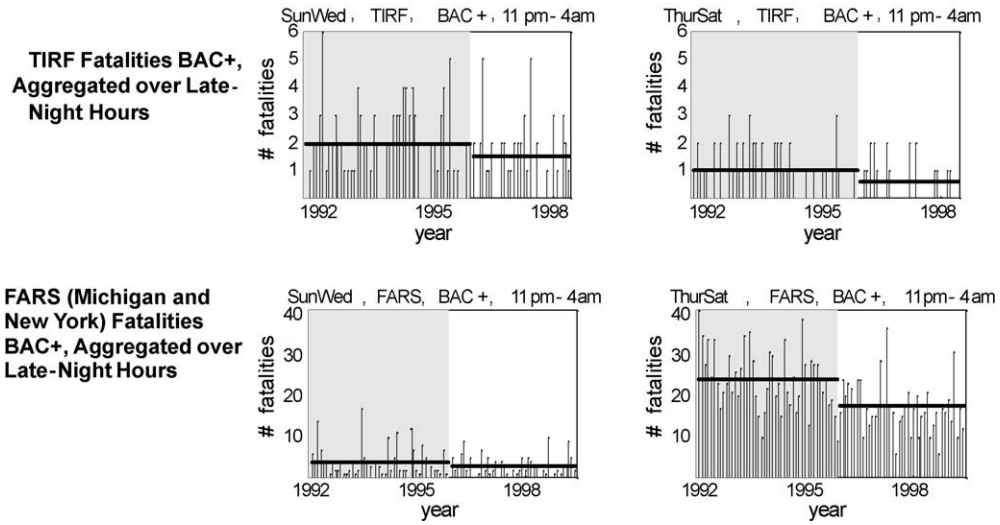

Fig. 1. Total monthly BAC positive TIRF and FARS driver fatalities by weekgroup aggregated over late-night hours. The regression lines indicate linear trends. The shaded area corresponds to the pre-intervention period up to and including April 1996.

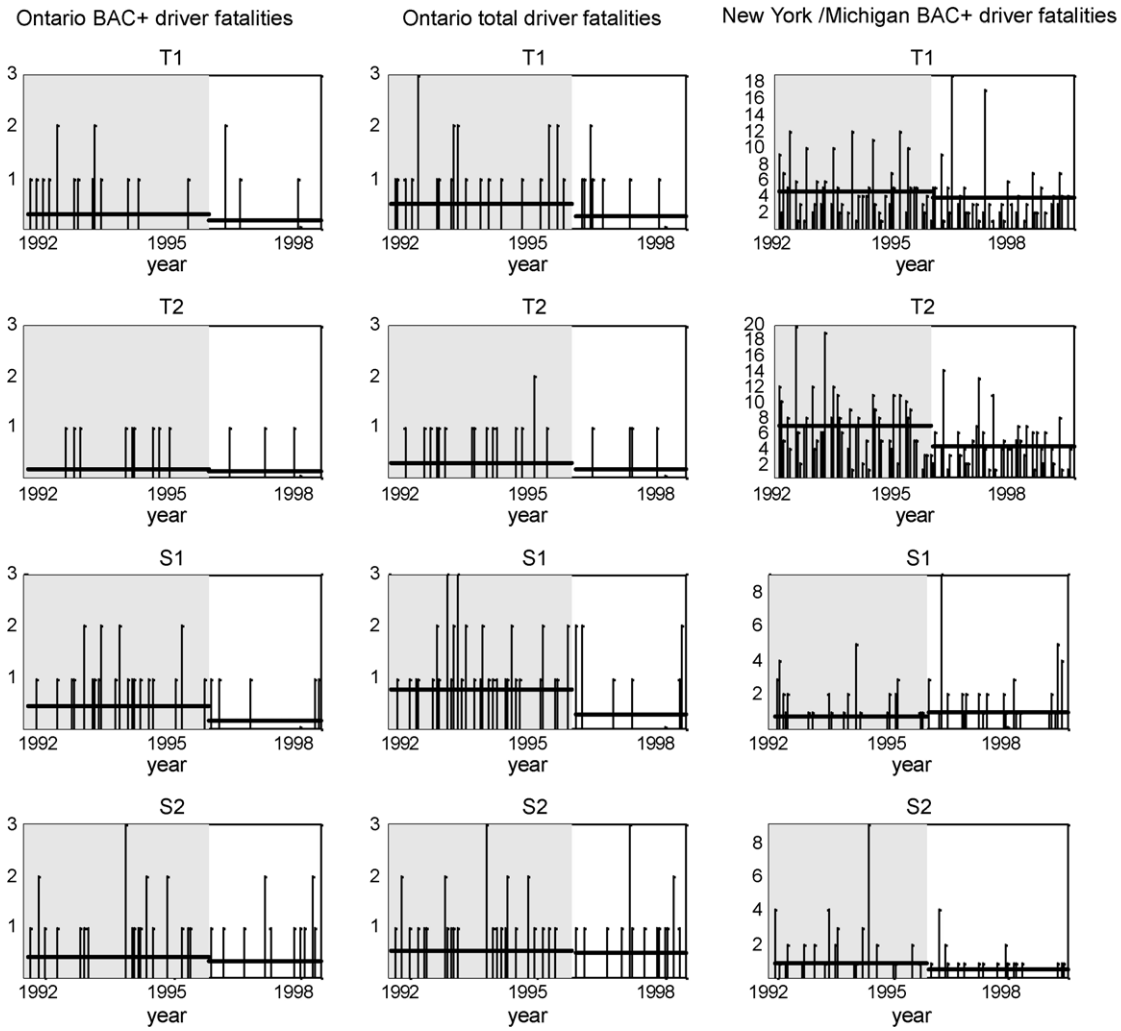

Fig. 2. Monthly BAC positive and total driver fatalities for Ontario and monthly BAC positive driver fatalities for New York–Michigan by weekgroup for 1–2 a.m. and 2–3 a.m. The regression lines indicate linear trends. The shaded area corresponds to the pre-intervention period up to and including April 1996. T1, Friday–Sunday morning 1–2 a.m.; T2, Friday–Sunday morning 2–3 a.m.; S1, Monday–Thursday morning 1–2 a.m.; S2, Monday–Thursday morning 2–3 a.m.

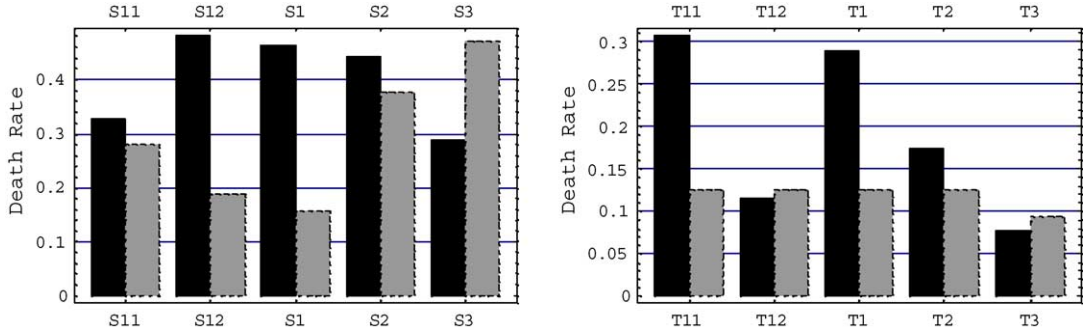

Fig. 3. Average BAC + driver fatality rate (number of deaths/month) by time of night and weekgroup. Black bars correspond to the pre-amendment death rate and the second one, gray bars correspond to the post-amendment death rate. S11, Sunday–Wednesday 11 p.m.–12 a.m.; S12, Sunday–Wednesday, 12–1 a.m., etc. T11, Thursday–Saturday 11 p.m.–12 a.m.; T12, Thursday–Saturday 12–1 a.m., etc.

p.m.–12 a.m. and 1–2 a.m. while following the amendment the distribution flattened over the different time periods.

4. Discussion

These findings appear to support the contention of Room et al. (2002) and Skog (1990, 2003) that the effects of smaller changes in alcohol availability may be variable or negligible. In Ontario, the drinking in licensed establishments was extended for only 1 h and thus possible effects on motor vehicle fatalities were expected to be small. Multiple measures were gathered to enhance validity by seeking convergence of findings, thereby enhancing the interpretability of findings.

In spite of an increase of 1 h in the hours of alcohol sale by licensed establishments, no increases in BAC positive driver fatalities were observed in Ontario after the amendment to extend drinking hours, even when controlling for overall trends in BAC negative driver fatalities. These findings are supported by data obtained from a survey of licensed establishments conducted as part of this evaluation, which indicated that many licensed establishments did not implement the extended drinking hours and indeed the hours of closing were quite variable among licensed establishments across Ontario. For example, of the 17% of licensed establishments most likely to stay open late, bars and taverns, about 45% remained open until 2 a.m. Sunday through Wednesday nights, two-thirds reported remaining open until 2 a.m. on Thursday and somewhat over four-fifths reported staying open until 2 a.m. on Friday and Saturday, although the low response rate limits the generalizability of these findings. Other types of licensed establishments, such as restaurants, were much less likely to stay open until 2 a.m. This would suggest that alcohol availability might not have substantively increased in spite of the regulation change. Other factors may have determined the hours of operation for licensed establishments.

BAC positive driver fatality trends reflected downward trends for Sunday–Wednesday 12–2 a.m. and Thursday–Saturday 1–2 a.m. for Ontario, and downward trends for Thursday–Saturday 12–1 a.m. and 2–3 a.m. for New York and Michigan, suggesting diverging patterns between the extended drinking hours jurisdiction of Ontario and the control jurisdictions of New York and Michigan. However, the trends in total driver fatalities and BAC positive driver fatalities for Ontario were similar. If New York and Michigan are to be considered the expected trend, the lack of concomitant significant reductions in Ontario for Thursday–Saturday between 12–1 a.m. and 2–3 a.m. could suggest that the extended drinking hours moderated the expected downward trend. However, there are lower BAC testing rates and a much higher number of total driver fatalities for New York and Michigan. This issue makes it difficult to assume that the New York and Michigan data are an ideal control series. Ontario total driver fatalities, on the other hand demonstrates more similar patterns to Ontario BAC positive driver fatalities.

An inspection of the pre- and post-amendment distribution curves for BAC positive driver fatalities for Ontario in Fig. 3 suggests that two different phenomena may be occurring for Sunday–Wednesday and Thursday–Saturday nights. For Sunday–Wednesday nights, the pre-amendment 12–2 a.m. peaks for BAC positive driver fatalities seems to have shifted to 2–4 a.m. post-amendment, while for Thursday–Saturday the 11 p.m.–12 a.m. and 1–2 a.m. pre-amendment peaks seem to have decreased and flattened out over the 11 p.m.–4 a.m. time periods. These differing distributions could suggest different patterns of drinking for weekdays and weekends by patrons of licensed establishments. It could well be that problem drinkers are more likely to engage in weekday evening drinking and drink until closing hour, while social drinkers are more likely to go out on weekends for short drinking episodes so they may not be engaging in an extra hour of alcohol consumption that is possible with the extended drinking hours. Rather the extra hour may be providing drinkers with the opportunity to go to licensed establishments an hour later, a finding reflected in the Bolton's (1996) survey of alcohol licensing violations inspectors that found that some establishments had increased sales while other establishments stated sales were the same because patrons were arriving and leaving later.

Other evidence corroborates the road safety findings. The alcohol sales data reveal decreases in beer sales, the most commonly sold beverage in taverns and bars (Gruenewald and Ponicki, 1995). Additionally, the survey of licensed establishments found that almost two-thirds of respondents observed no increases in alcohol sales following the increase in drinking hours. Thus, the different data sets converge to suggest that the road safety impact of these smaller changes in availability was minimal in Ontario as a whole.

It is also possible that drinking-driving fatality rates were changing in response to several factors including a number of road safety initiatives that occurred within a 2-year interval before and after the change in hours of sale. Ontario introduced a Graduated Licensing System in the spring of 1994 and a 90-day Administrative Driver's Licence Suspension for those charged with a drinking-driving offence, on 28 November 1996. Both these initiatives have been associated with reductions in drinking-driving behaviour, and collisions and alcohol-related driver fatalities (Boase and Tasca, 1998; Mann et al., 2000, 2002). Thus, these initiatives may have created a declining trend in the drinking-driving problem that masked the effects of a small increase in alcohol availability.

Finally, the impact of extended drinking hours would be limited to those who drink in licensed establishments during early morning hours. Although these establishments are a substantial source of the proportion of drinking drivers (Interministerial Committee on Drinking Driving, 1988), those who typically drink at home or at parties would not necessarily be affected by the longer hours.

In summary therefore, it is possible that the limitations of the study and other policy initiatives may have masked any significant findings. The fact that many licensed establishments did not seem to change their hours of closing meant that alcohol availability may not have increased dramatically.

These results are consistent with the international literature in suggesting that the effects of small increases in alcohol availability may be minimal, or masked by other factors (Chikritzhs et al., 1997; Room et al., 2002; Skog, 1990, 2003). The small change in policy, the limited implementation and other societal factors such as economic conditions and road safety countermeasures may have mitigated any effect on alcohol-related motor vehicle fatalities in Ontario.

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