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Effects of Smoke-Free Laws on Alcohol-Related Car Crashes in California and New York: Time Series Analyses From 1982 to 2008

Debra H. Bernat, PhD,
College of Medicine, Florida State University, Tallahassee

Mildred Maldonado-Molina, PhD,
Department of Health Outcomes and Policy, University of Florida, Gainesville

Andrew Hyland, PhD, and
Roswell Park Cancer Institute, Buffalo, NY

Alexander C. Wagenaar, PhD
Department of Health Outcomes and Policy and the Institute for Child Health Policy, University of Florida

Abstract

We examined effects of New York and California's statewide smoke-free restaurant and bar polices on alcohol-related car crash fatalities. We used an interrupted time-series design from 1982 to 2008, with 312 monthly observations, to examine the effect of each state's lawonsingle-vehicle-nighttime crashes and crashes involving a driver with a blood alcohol concentration of 0.08 grams per deciliter or greater.

Implementation of New York and California's statewide smoke-free policies was not associated with alcohol-related car crash fatalities. Additionally, analyses showed no effect of New York's smoke-free policy on alcohol-related car crash fatalities in communities along the Pennsylvania-New York border.

Statewide smoke-free restaurant and bar laws do not appear to affect rates of alcohol-related car crashes.

Restricting smoking in public places has become an essential component of tobacco control worldwide. Smoke-free policies reduce secondhand smoke exposure,[1–6] and may have other important public health benefits including reducing opportunities to smoke, changing smoking norms, and reducing smoking rates.[7–10] Despite beneficial public health effects of smoke-free policies, a specific study has raised the possibility of serious deleterious side

Correspondence should be sent to Debra H. Bernat, Florida State University, College of Medicine, 1115 West Call St., P.O. Box 3064300, Tallahassee, FL 32306 (debra.bernat@med.fsu.edu).

Contributors

D. H. Bernat and A. C. Wagenaar jointly designed and led the study, with advice from A. Hyland. D. H. Bernat and M. Maldonado-Molina conducted data analyses. D. H. Bernat and A. C. Wagenaar led the drafting of the article, with contributions from M. Maldonado-Molina and A. Hyland.

Note. The findings and conclusions are solely the authors' and do not necessarily represent the views of the National Institutes of Health, Florida State University, Roswell Cancer Institute, or the University of Florida.

Human Participant Selection

This study was classified as exempt research in terms of human subjects review because all data were obtained from public-use datasets.

effects of smoke-free laws on alcohol-related car crashes. Using jurisdictions that implemented smoking bans between 2000 and 2005, Adams and Cotti found that smoke-free bars in the United States were associated with a 13% increase in annual traffic fatalities involving drivers with a blood alcohol content (BAC) of 0.08 grams per deciliter or greater.[11]

There are several plausible mechanisms by which alcohol-related traffic crashes might increase or decrease as a result of smoke-free restaurant and bar laws. First, studies suggest that policies that reduce smoking may also reduce alcohol consumption and related problems. In economic terms, alcohol and tobacco appear to be complements.[12] Dee, for example, showed that higher cigarette taxes were associated with reductions in adolescent alcohol use.[13] Smoke-free laws may also increase the number of restaurant or bar patrons that are nonsmokers and decrease the number of patrons that are smokers. This change in patronage may lead to an overall reduction in alcohol use because nonsmokers are less likely to drink alcohol than are smokers, and also less likely to be heavy drinkers.[14] Smoke-free laws, however, are not universal, and as such, patrons may travel further distances to patronize bars that do allow smoking (perhaps across a jurisdictional border to another city or state).[11] Because the majority of smoke-free laws occur at the local and state levels, driving to another restaurant or bar that is not bound by a smoke-free law, or that has outdoor seating, is feasible in many situations. Because smokers are more likely to be drinkers, cross-border shopping could result in intoxicated individuals driving greater distances, increasing crash risk exposure, resulting in a greater number of alcohol-related crashes and fatalities.

The present study addresses the dearth of studies in the literature by examining the possible unintended consequences of smoke-free laws on alcohol-related car crashes. To date, only 1 study has examined this relationship and showed a 13% increase in alcohol-related fatal crashes associated with smoke-free bar policies.[11] This study, however, has several important limitations. First, states that enacted smoke-free policies prior to 2000, which provide the longest follow-up periods, were omitted from the study. Second, despite aggregating alcohol-related car crash data for each county annually, counties remained with no alcohol-related fatal traffic crashes and were omitted from the analysis. Finally, both local and statewide smoke-free policies were included and it is possible that the effects of these policies on alcohol-related car crashes differ. The present study addresses these limitations by examining the effects of smoke-free laws in the first 2 large states that passed 100% statewide smoke-free restaurant and bar laws in the United States—California and New York. Given the widespread prevalence of statewide smoke-free policies, it is important to assess potential unintended consequences of smoke-free policies on alcohol-related traffic fatalities.

METHODS

We used an interrupted time-series design to examine the effects of New York and California's 100% statewide smoke-free restaurant and bar laws on alcohol-related fatal traffic crashes from 1982 to 2008 (312 repeated monthly measures).[15] New York's 100% statewide smoke-free restaurant and bar law went into effect on July 24, 2003; California's law went into effect on January, 1, 1998. We selected the 1982 to 2008 study period for several reasons: (1) it provided a long time-series for maximum statistical power, (2) it allowed the use of data of consistently high quality with only minor measurement system changes, and (3) it made maximum use of all available alcohol-related traffic crash data provided by Fatality Analysis Reporting System (FARS).

Measures

Smoke-Free Laws—Information on smoke-free laws was obtained from the American Non-smokers' Rights Foundation, which has tracked data on all local and statewide smoke-free laws in the United States. The American Nonsmokers' Rights Foundation's US Tobacco Control Laws Database includes effective dates for all statewide restaurant and bar policies enacted, weakened, and repealed in the United States. Using these data, we examined all local 100% smoke-free restaurant and bar laws implemented in New York or California prior to the effective date of the statewide law. These data showed that very few areas in New York had implemented both strong (100%) smoke-free restaurant and bar laws prior to the statewide law, and the bar laws that were implemented were done so within 4 months of the statewide law. Although more cities and counties in California implemented strong smoke-free restaurant and bar laws prior to the statewide law, the overall percentage of the population covered by these local laws was low (only 2% of the state's total population). Because coverage of local smoke-free policies restricting smoking in restaurants and bars was so limited, we focused our analyses on effects of the statewide laws only. New York's statewide smoke-free restaurant and bar law was represented as a dichotomous variable, where "0" was entered prior to August 1, 2003, and "1" thereafter. Similarly, California's statewide smoke-free restaurant and bar law was represented as a dichotomous variable, where "0" was entered prior to January 1, 1998, and "1" thereafter.

Alcohol-Related Fatal Traffic Crashes—Two measures of alcohol-related fatal traffic crashes were included in the present study: single-vehicle-nighttime (SVN) fatal crashes and crashes involving a BAC of 0.08 grams per deciliter or greater, both limited to drivers 21 years of age and older. Data on alcohol-related fatal traffic crashes were obtained from the FARS maintained by the National Highway Traffic Safety Administration. FARS includes information on every traffic crash in the United States that results in at least 1 fatality within 30 days of the crash. Crashes involving youths younger than 21 years were not included in the analyses to avoid confounding with several other (effective) policy changes specifically for drivers younger than 21 years, such as zero or near-zero BAC limits[16] and increases in the legal drinking age.[17]

Single-vehicle-nighttime (SVN) fatal traffic crashes were chosen as one of the outcome variables because previous research has shown that late-night single-vehicle crashes are much more likely to involve alcohol than are multiple-vehicle crashes or single-vehicle crashes that occur during the day.[18] The SVN outcome indicator is consistent over time and across states, and not affected by enforcement practices and perceptions. Single-vehicle-nighttime crashes were defined as crashes occurring between 9:00 PM and 5:59 AM among drivers 21 years of age and older in a passenger vehicle. Single-vehicle crashes were defined as crashes involving 1 moving vehicle. Effects were examined on both counts and rates of SVN fatal traffic crashes. The rate (per 100 000 population) of SVN crashes was calculated by month and year (number of single-vehicle-nighttime crashes each month involving a driver aged ≥ 21 years divided by the population of adults ≥ 21 years of age).

Fatal traffic crashes involving a BAC over the current legal limit (0.08 g/dL) were also examined. BAC information has been collected from drivers involved in fatal traffic crashes and included in FARS dating back to 1982. These data, however, are missing for a not insignificant portion of fatal traffic crashes. To avoid biases because of missing data, the National Highway Traffic Safety Administration has created a multiple imputed data set (n = 10 imputations) for BAC level of drivers. Initially, models included counts and rates of the mean number of drivers (across the 10 data sets) with a BAC greater than 0.08 grams per deciliter. If statistically significant effects were found, statistical models with BAC outcome

measures were reestimated 10 times and combined to obtain final parameter estimates and standard errors.

Data Analysis

We used interrupted time series models (i.e., Box-Jenkins ARIMA models) to estimate effects of New York and California's statewide smoke-free restaurant and bar laws on alcohol-related fatal traffic crashes using monthly data from January 1982 to December 2008. Two measures of alcohol-related car crashes were examined, including single-vehicle nighttime fatal traffic crashes and crashes involving a driver with a BAC of 0.08 or greater. The outcome in all other states (e.g., excluding the study state) was used as a covariate in the statistical models to control for trends in fatal traffic crashes over time because of many causal factors operating in common across states. We included seasonal (lag 12) differencing and moving average factors and first-order (lag 1) differencing and moving average factors to control for autocorrelation patterns (Figure 1). Each model within each state was developed independently, using the conventional identification, estimation, and diagnostic strategy of Box and Jenkins.[19] Results were based on combined ARIMA-transfer function models with white noise residuals, producing unbiased error estimates.

Similar methods were used to separately examine the effect of New York's statewide smoke-free restaurant and bar law on fatal traffic crashes in (1) New York communities that border Pennsylvania (light gray), (2) Pennsylvania communities that border New York (dark gray), and (3) communities that border New York and Pennsylvania (all shaded communities) to examine possible effects of cross-border shopping (Figure 2). Counts of alcohol-related fatal traffic crashes were analyzed, controlling for population (age ≥ 20 years). Because of the relatively small number of fatal traffic crashes in these communities, counts of fatal traffic crashes were analyzed quarterly.

RESULTS

Implementation of New York's 100% statewide smoke-free law in restaurants and bars had no measurable effect on single-vehicle nighttime fatal traffic crashes or crashes involving drivers with a BAC of 0.08 grams per deciliter or greater (Table 1). Similar results were found in California, where the law was implemented a half decade earlier. Results are consistent in both the unadjusted and adjusted models (including the outcome in all other states in the United States to control for many other factors affecting alcohol-related car crash counts over time), and when controlling for population (e.g., crash rates).

We also examined the effects of the smoke-free law in New York on alcohol-related fatal traffic crashes along the New York–Pennsylvania border because some have hypothesized that patrons may travel to neighboring states to patronize restaurants and bars that allow smoking, and that such additional travel to and from bars and restaurants might increase alcohol-related crash rates (Table 2). Results revealed no measurable effects of smoke-free policies on alcohol-related fatal traffic crashes in New York counties bordering Pennsylvania, Pennsylvania counties bordering New York, or the New York–Pennsylvania border counties combined. Results were consistent across the unadjusted and adjusted models (controlling for population in the border communities as a covariate).

DISCUSSION

The present study examined the effects of smoke-free restaurant and bar polices on alcohol-related car crash fatalities. Using nearly 3 decades of data in the most populous states in the United States—New York and California—we found no evidence for an association between strong statewide smoke-free restaurant and bar policies and alcohol-related car

crashes. Findings are robust, consistent across 2 geographically diverse states and across time with smoke-free policies implemented a half decade apart.

In contrast to the present study, Adams and Cotti reported a 13% increase in alcohol-related car crashes associated with the implementation of smoke-free laws in the United States.[11] A primary difference between our study and this previous study is the unit of analysis. County was the unit of analysis in the Adams and Cotti study, and state was the unit of analysis in the present study. This is significant for 2 reasons. First, the smaller unit of analysis in the Adams and Cotti study resulted in having numerous localities with zero alcohol-related car crash fatalities annually. The authors used the logarithm of the number of crashes as their outcome, and because it is not possible to take a log of zero, the authors simply omitted counties with zero alcohol-related fatalities from their analysis. Omitting all counties with no alcohol-related car crashes may have biased their effect upwards. Adams and Cotti also included both local and statewide smoke-free policies in their analysis, and local policies seem likely to result in greater cross-border shopping than statewide laws. It is possible that local smoke-free policies might be associated with alcohol-related car crashes, whereas statewide policies are not. This is a topic for future research, but might become moot as strong statewide laws continue to spread.

We examined whether New York's statewide smoke-free restaurant and bar policy was associated with alcohol-related car crashes specifically in communities along the New York-Pennsylvania border. Pennsylvania did not have a statewide smoke-free policy in effect during the study period and only 1 community along the Pennsylvania border had enacted a local smoke-free law. Consistent with the cross-border shopping hypothesis proposed by Adams and Cotti,[11] our analysis examined whether New York residents might have traveled to Pennsylvania to patronize a restaurant or bar that did not have a smoke-free law. If this were the case, one would hypothesize an increase in alcohol-related car crash fatalities in the New York–Pennsylvania border communities. Our results, however, showed no association between New York's smoke-free policy and alcohol-related car crashes in communities along the New York border, the Pennsylvania border, or the New York–Pennsylvania border combined. Thus, our results do not support a cross-border shopping hypothesis.

Studies to date on the effects of smoke-free laws on other alcohol-related outcomes, including alcohol consumption[20–22] and alcohol-related crime,[23] are equivocal. Picone et al., for example, found that smoking bans reduced alcohol consumption using 6 waves of the Health and Retirement Survey.[22] Similarly, Gallet and Eastman found that smoke-free laws in restaurants and bars were associated with reduced demand for beer and spirits.[20] Hahn et al., however, found no association between local smoke-free policies and alcohol consumption among college students.[21] Most recently, Klein et al. examined effects of smoke-free restaurant and bar policies on alcohol-related crime around alcohol-licensed businesses in St. Paul, Minnesota.[23] They found no association between smoke-free policies and alcohol-related crime around these establishments. These studies, along with the present analyses of traffic crashes, indicate that smoke-free policies either reduce, or are not associated with, alcohol use or alcohol-related health and safety outcomes.

Smoke-free laws are an important component of tobacco control, reducing secondhand smoke exposure and cigarette smoking among adults and youths. Perceived deleterious side effects of policies may discourage policymakers from enacting smoke-free laws. Thus, the findings of the present study, indicating no association between smoke-free laws and alcohol-related fatal traffic crashes, are positive for continued dissemination and strengthening of smoke-free laws across the United States. Examining unintended, as well as intended, consequences of policies is an important component of public health law evaluation research.

Although there are many strengths of the current study, there are also limitations. First, New York lowered the legal statewide BAC limit from 0.10 to 0.08, a month prior to the statewide smoke-free law.[24] Although it is common for states to enact multiple laws at once, it makes it difficult to distinguish the unique effect of the statewide smoke-free restaurant and bar policy on fatal traffic crashes in New York. Research shows that lowering the legal BAC limit to 0.08 from 0.10 reduces alcohol-related fatal traffic crashes,[25] and 1 previous study suggested that smoke-free laws may increase fatal traffic fatalities.[11] It is possible that the effects of these 2 simultaneous policy changes cancelled each other out, showing no net effect in the current study. Perhaps the smoke-free policy increased alcohol-related fatal traffic crashes and the reduced legal BAC limit lowered fatal traffic crashes. However, the replication of the results of no effect of smoke-free policies on car crashes in California is inconsistent with this explanation for the New York results, because there was no change in California's adult BAC limits from 1998 to 2008.

We evaluated effects of smoke-free policies in only 2 states. Although the optimal research design would include more states, we selected the most populous states with clear strong statewide smoke-free restaurant and bar policies, maximizing power to detect any effects on car crashes. Additionally, these states were among the first to implement statewide smoke-free laws, and thus have the longest follow-up time, further increasing statistical power.

In conclusion, the results of the present study clearly do not support an association between strong statewide smoke-free laws and alcohol-related car crash fatalities. The results were replicated across 2 states, during different time periods, reducing potential threats to internal validity, and specific cultural, economic, or regional confounds.[26] We found no support for the hypothesis of deleterious side effects of smoke-free policies on alcohol-related crashes.

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References

1. Centers for Disease Control and Prevention. Reduced secondhand smoke exposure after implementation of a comprehensive statewide smoking ban—New York, June 26, 2003–June 30, 2004. MMWR Morb Mortal Wkly Rep. 2007; 56 (28):705–708. [PubMed: 17637596]
2. Farrelly MC, Nonnemaker JM, Chou R, Hyland A, Peterson KK, Bauer UE. Changes in hospitality workers' exposure to secondhand smoke following the implementation of New York's smoke-free law. Tob Control. 2005; 14(4):236–241. [PubMed: 16046685]
3. Pickett MS, Schober SE, Brody DJ, Curtin LR, Giovino GA. Smoke-free laws and secondhand smoke exposure in US non-smoking adults, 1999–2002. Tob Control. 2006; 15(4):302–307. [PubMed: 16885579]
4. Repace J. Respirable particles and carcinogens in the air of delaware hospitality venues before and after a smoking ban. J Occup Environ Med. 2004; 46(9):887–905. [PubMed: 15354053]
5. Siegel M, Albers AB, Cheng DM, Biener L, Rigotti NA. Effect of local restaurant smoking regulations on environmental tobacco smoke exposure among youths. Am J Public Health. 2004; 94(2):321–325. [PubMed: 14759949]
6. Stark MJ, Rohde K, Maher JE, et al. The impact of clean indoor air exemptions and preemption policies on the prevalence of a tobacco-specific lung carcinogen among nonsmoking bar and restaurant workers. Am J Public Health. 2007; 97(8):1457–1463. [PubMed: 17600262]

7. Levy DT, Chaloupka F, Gitchell J. The effects of tobacco control policies on smoking rates: a tobacco control scorecard. J Public Health Manag Pract. 2004; 10(4):338–353. [PubMed: 15235381]
8. Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behaviour: systematic review. BMJ. 2002; 325(7357):188. [PubMed: 12142305]
9. Hahn EJ, Rayens MK, Butler KM, Zhang M, Durbin E, Steinke D. Smoke-free laws and adult smoking prevalence. Prev Med. 2008; 47(2):206–209. [PubMed: 18519154]
10. Siegel M, Albers AB, Cheng DM, Hamilton WL, Biener L. Local restaurant smoking regulations and the adolescent smoking initiation process: results of a multilevel contextual analysis among Massachusetts youth. Arch Pediatr Adolesc Med. 2008; 162(5):477–483. [PubMed: 18458195]
11. Adams S, Cotti C. Drunk driving after the passage of smoking bans in bars. J Public Econ. 2008; 92(5–6):1288–1305.
12. Göhlmann, S.; Requate, T.; Schmidt, C.; Tauchmann, H. [Accessed January 2, 2009] Tobacco and alcohol: complements or substitutes? A structural model approach. CEPR Discussion Paper no 6780. 2008. Available at: http://www.cepr.org/pubs/dps/DP6780.asp
13. Dee TS. State alcohol policies, teen drinking and traffic fatalities. J Public Econ. 1999; 72(2):289–315.
14. Bierut LJ, Schuckit MA, Hesselbrock V, Reich T. Co-occurring risk factors for alcohol dependence and habitual smoking. Alcohol Res Health. 2000; 24(4):233–241. [PubMed: 15986718]
15. Wagenaar, AC.; Komro, KA. PHLR Methods Monograph Series. 2011. Natural Experiments: Design Elements for Optimal Causal Inference.
16. Wagenaar AC, O'Malley PM, LaFond C. Lowered legal blood alcohol limits for young drivers: effects on drinking, driving, and driving-after-drinking behaviors in 30 states. Am J Public Health. 2001; 91(5):801–804. [PubMed: 11344892]
17. Wagenaar AC, Toomey TL. Effects of minimum drinking age laws: review and analyses of the literature from 1960 to 2000. J Stud Alcohol Suppl. 2002; 14:206–225. [PubMed: 12022726]
18. National Highway Traffic Safety Adminstration. Traffic safety facts 2001. Washington, DC: National Highway Traffic Safety Administration; 2002. DOT HS 809 484
19. Box, G.; Jenkins, GM. Time Series Analysis: Forecasting & Control. 2. Englewood Cliffs, NJ: Prentice Hall; 1976.
20. Gallet CA, Eastman HS. The impact of smoking bans on alcohol demand. Soc Sci J. 2007; 44(4): 664–676.
21. Hahn EJ, Rayens MK, Ridner SL, Butler KM, Zhang M, Staten RR. Smoke-free laws and smoking and drinking among college students. J Community Health. 2010; 35(5):503–511. [PubMed: 20112055]
22. Picone GA, Sloan F, Trogdon JG. The effect of the tobacco settlement and smoking bans on alcohol consumption. Health Econ. 2004; 13(10):1063–1080. [PubMed: 15386690]
23. Klein, EG.; Forster, J.; Toomey, TL.; Erickson, DJ.; Collins, N. Does banning smoking in bars and restaurants increase alcohol-related crime?. Presented at the 139th Annual Meeting of the American Public Health Association; October 29–November 2; Washington, DC. 2011.
24. N.Y. VAT. LAW § 1192 (2003).
25. Bernat DH, Dunsmuir WT, Wagenaar AC. Effects of lowering the legal BAC to 0.08 on single-vehicle-nighttime fatal traffic crashes in 19 jurisdictions. Accid Anal Prev. 2004; 36 (6):1089–1097. [PubMed: 15350886]
26. Shadish, ML.; Cook, TD.; Campbell, DT. Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Boston, MA: Houghton Mifflin Co; 2002.

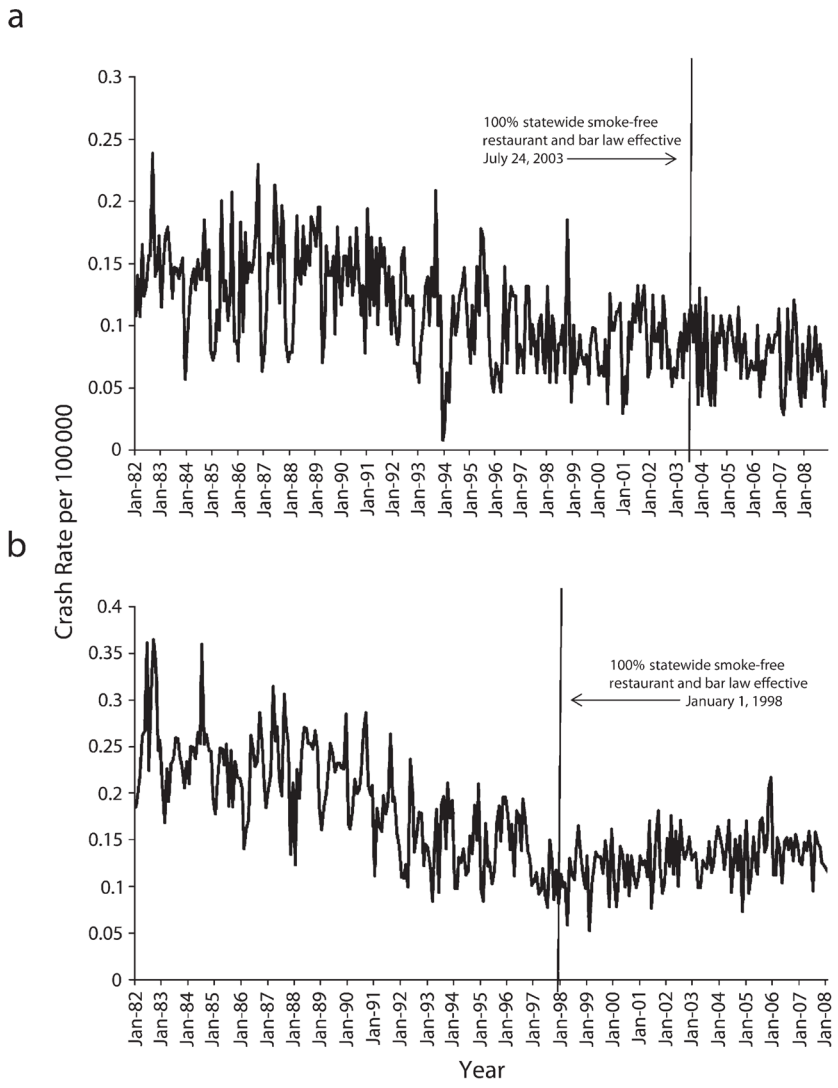

FIGURE 1.
Time series of single-vehicle nighttime fatal traffic crash rate (per 100 000) in (a) New York and (b) California: 1982–2008.

FIGURE 2.
Counties in New York (NY) and Pennsylvania (PA) included in border analysis.

TABLE 1

ARIMA Models of New York (NY) and California (CA) 100% Smoke-Free Restaurant and Bars Laws on Alcohol-Related Fatal Traffic Crashes: 1982–2008

	NY Unadjusted Model		NY Adjusted Model[a]		CA Unadjusted Model		CA Adjusted Model[a]	
Outcome	**B (SE)**	***P***	**B (SE)**	***P***	**B (SE)**	***P***	**B (SE)**	***P***
SVN fatal traffic crashes								
Count	1.88 (3.15)	.55	1.29 (3.15)	.68	3.88 (4.09)	.34	3.28 (3.67)	.37
Rate[b]	0.01 (0.02)	.57	0.01 (0.02)	.7	0.02 (0.02)	.36	0.02 (0.02)	.39
Fatal traffic crashes involving drivers with ≥ 0.08 BAC								
Count	2.33 (1.71)	.18	2.00 (1.66)	.23	1.44 (2.48)	.55	1.33 (2.32)	.57
Rate[b]	0.02 (0.01)	.21	0.01 (0.01)	.26	0.01 (0.01)	.57	0.01 (0.01)	.59

Note. BAC = blood alcohol content; SVN = single-vehicle nighttime.

[a]Adjusted for outcome in remaining states in United States.

[b]Rate per 100 000 population.

TABLE 2

ARIMA Model of NY 100% Smoke-Free Restaurant and Bars Law on Single-Vehicle Nighttime (SVN) Fatal Traffic Crash Counts in New York (NY) and Pennsylvania (PA) Border Communities: 1982–2008

	Unadjusted Model		Adjusted Model[a]	
SVN Fatal Traffic Crashes	**B (SE)**	***P***	**B (SE)**	***P***
NY border communities	−0.43 (1.74)	.81	−0.28 (1.75)	.87
PA border communities	0.99 (1.35)	.46	0.36 (0.94)	.7
NY–PA border communities	0.31 (2.29)	.89	0.27 (2.30)	.91

[a]Adjusted for population in border communities