The Effect of Restricting Opening Hours on Alcohol-Related Violence

Sergio Duailibi, MD, PhD, William Ponicki, MA, Joel Grube, PhD, Ilana Pinsky, PhD, Ronaldo Laranjeira, MD, PhD, and Martin Raw, PhD

Objective. We investigated whether limiting the hours of alcoholic beverage sales in bars had an effect on homicides and violence against women in the Brazilian city of Diadema. The policy to restrict alcohol sales was introduced in July 2002 and prohibited on-premises alcohol sales after 11 PM.

Methods. We analyzed data on homicides (1995 to 2005) and violence against women (2000 to 2005) from the Diadema (population 360 000) police archives using log-linear regression analyses.

Results. The new restriction on drinking hours led to a decrease of almost 9 murders a month. Assaults against women also decreased, but this effect was not significant in models in which we controlled for underlying trends.

Conclusions. Introducing restrictions on opening hours resulted in a significant decrease in murders, which confirmed what we know from the literature: restricting access to alcohol can reduce alcohol-related problems. Our results give no support to the converse view, that increasing availability will somehow reduce problems. (*Am J Public Health.* 2007;97:2276–2280. doi:10.2105/AJPH.2006.092684)

Restricting alcohol availability may reduce alcohol consumption and associated harm, including violence.[1] Conversely, relaxing restrictions on the availability of alcohol may lead to increased consumption and problems.[2–6] Thus, for example, neighborhoods that have more bars and alcohol outlets per capita experience more violence.[7–9] Studies of licensing hours have for the most part investigated only modest changes (e.g., extending closing times from midnight to 1:00 AM). Such changes might be expected to have only minimal effects. Moreover, these studies have been limited to North America, Europe, or Australia. No studies have examined the effects of changes in sales hours in developing countries, where the alcohol market is largely unregulated. Going beyond previous research, we report on the effects on assaults on women and homicides of a new law significantly restricting sales hours for bars in the Brazilian city of Diadema.

A significant proportion of the Brazilian population (17% of men and 6% of women) report alcohol-related problems.[10,11] During 1988–1999, more than 84% of hospital admissions for addictions related to alcohol.[12] Alcohol-related violence is also a serious problem. A 1995 São Paulo study found that alcohol was involved in 18 000 homicides, 15% of the 120 111 studied.[13] An analysis of 130 homicides in Curitiba from 1990 to 1995 showed that 54% of the victims and 60% of the perpetrators were under the influence of alcohol during the crime.[14] These findings highlight the urgent need for new and effective alcohol control policies in Brazil, yet there are few. There is a minimum age to buy and drink alcohol (18 years), there are time restrictions on advertising liquor, although not beer or wine (no television advertising allowed between 6 AM and 9 PM), and the blood alcohol limit for drivers is 0.06 g/L. However these policies are poorly enforced, alcohol is cheap and readily available, and there is a high density of retail outlets that sell alcohol (e.g., 1 for every 16 people in a São Paulo suburb).[15]

Diadema, 20 km from the center of São Paulo, is an industrial city with a population (357 064) of predominantly low socioeconomic status. In 1999, Diadema had one of the highest homicide rates in Brazil (103 per 100 000 inhabitants), of which 65% were alcohol related.[16] The mayor was concerned about the high murder rate, and police statistics showed that most murders and assaults on women occurred in or close to bars between 11 PM and 6 AM. As a result, in July 2002, a new law was introduced in Diadema that closed all bars at 11 PM. Before the law, most bars remained open 24 hours. To evaluate the effect of the new licensing law, we addressed the questions: do the new restrictions reduce murders or assaults against women or both?

METHODS

We obtained monthly counts of homicides and assaults against women from Diadema police records. The homicide data covered January 1995 to July 2005; the assault data covered July 2000 to July 2005. Monthly crime data were converted to per capita rates using interpolated annual Diadema population estimates obtained from the Brazilian Institute of Geography and Statistics. The population increased approximately 20% over the 10-year study.

We used linear regression analyses to estimate the effect of the law on logged monthly rates of homicides and assaults against women per 1000 residents. These regressions corrected for first-order serial correlation using the Prais–Winsten 2-stage feasible generalized least squares estimator.[17] The effect of closing hours was modeled as a dummy variable with the value of 0 before July 2002, 0.5 in July 2002 (the law changed half-way through July), and 1 in later months. The regression coefficient on this variable indicated the change in the logged monthly crime rate that appeared to result from adoption of the law. In all models, we also controlled for percentage monthly unemployment rates in the São Paulo metropolitan region, which includes Diadema. This variable was used to control for the interaction between local economic conditions and crime rates. We added a dummy variable to identify months on or

after July 2004 to the homicide regressions to control for the effect of a national gun control law that took effect at that time.[18]

Two additional dummy variables were introduced into the homicide analyses to control for the influence of unrelated law enforcement interventions during the first half of 2000. The first dummy variable, which identified all months on or after January 2000, was used to control for a temporary anti–drug trafficking effort and the official creation of the Municipal Civil Guard to enforce the current closing-hours law. The second dummy variable identified all months on or after July 2000 and represented the initiation of actual operations for the Municipal Civil Guard. Because these law-enforcement interventions occurred at similar times, including both of them would have made it difficult to distinguish the effect of one from another. However, we preferred including both year-2000 intervention variables in the regression for a more conservative approach because it helped to avoid excluded variable bias when measuring the effect of the closing-hours law.

We estimated models with and without a linear time-trend variable to help control for unmeasured changes over time in other social, economic, and policy factors that affect violence. Data limitations restricted our ability to control for changes over time in potentially relevant local characteristics such as age distribution, poverty rate, number of alcohol outlets, or law enforcement activities. A linear time measure accounted for linear trends in factors that could not be explicitly controlled for in the regressions. The specifications that include a linear time variable were preferable because they helped to avoid excluded-variable biases.

RESULTS

Table 1 displays descriptive statistics of all variables used in the regressions. Figure 1 shows monthly homicide rates per 1000 residents. The monthly variation in homicide counts was large, ranging from 4 to 41. Homicides rose from 1995 to 1999 before dropping abruptly in early 2000, possibly in response to the new Municipal Civil Guard and anti–drug trafficking efforts at that time. Homicides averaged 22 per month and were relatively stable during the 2 years before the new closing-time law; they fell to about 12 per month during the 3 years after the law went into effect.

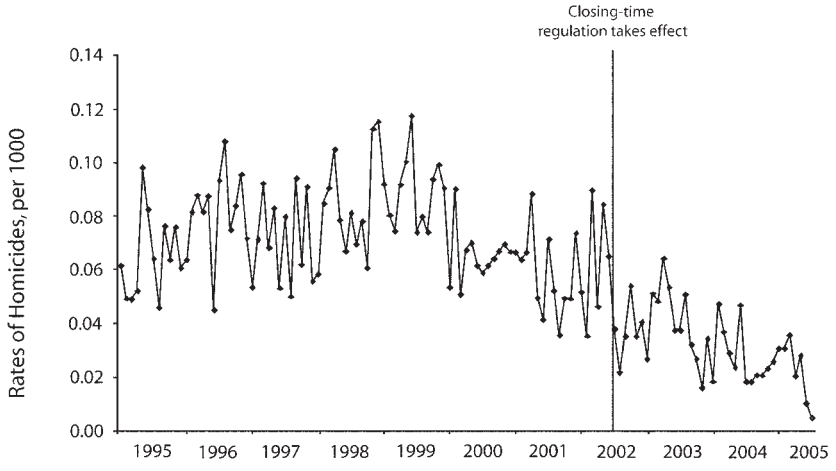
TABLE 1—Descriptive Statistics of All Variables Used to Estimate the Effect of the New Closing-Time Law: Diadema, Brazil, January 1995–July 2005

	Minimum	Maximum	Mean (SD)
Homicides, monthly rate per 1000 residents	0.005	0.117	0.061 (0.025)
Assaults against women, monthly rate per 1000 residents	0.026	0.198	0.094 (0.048)
Unemployment rate, %	12.100	20.700	17.406 (2.142)

Note. N = 127 months (January 1995 through July 2005) for homicides and unemployment rates.
[a]N = 61 months (July 2000 through July 2005) for assaults against women.

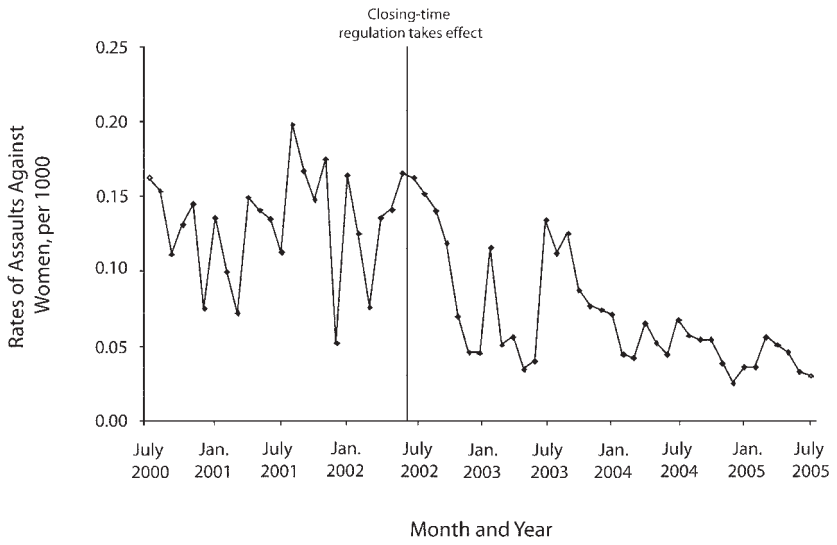
Table 2 summarizes the results of the homicide rate regressions. Analyses from all models indicated that the new closing time law led to a significant reduction in homicides. The bottom portion of the table presents estimates for the effect of the law on the count of homicides in Diadema during the 36 months after implementation. These figures were calculated by using the regression coefficients to simulate the number of assaults that would be expected each month under the alternative assumptions of the new law occurring or not. Results from the preferred model, which controlled for both previous enforcement changes and linear time trends, indicated that 319 homicides (95% CI=193, 445) were prevented during the first 3 years of the new law, a 44% decline from what would be expected without the law.

Table 2 also indicates that the July 2004 gun control law[18] led to a significant decline in homicides, although slightly smaller than the decline from the closing-time law. Regional unemployment rates were positively related to homicides in all models, but this effect was not significant in the preferred specification. The year-2000 enforcement change variables had nonsignificant negative effects on homicides when both were included in the model, although each one became significant when the other was excluded in models without time-trend controls (data not shown). This difference apparently resulted from collinearity between these indicators. The autocorrelation coefficients provided in Table 2 measure the



Note. Homicide rate for July 2005 is on the basis of a half-month of data.

FIGURE 1—Monthly rates of homicides per 1000 residents before and after new bar closing-time regulations: Diadema, Brazil, January 1995–July 2005.



Note. Assault rates for July 2000 and July 2005 are on the basis of half-months of data.

FIGURE 2—Monthly rates of assaults against women per 1000 residents before and after new bar closing-time regulations: Diadema, Brazil, July 2000–July 2005.

relation among residuals of the uncorrected first-stage regression. These coefficients were positive and significant in all models, indicating that each month's residual tended to be similar to its neighbors in an uncorrected model. The autocorrelation coefficients for the second-stage models were not significantly different from zero, indicating that Prais–Winsten correction for first-order serial correlation had adequately controlled for residual autocorrelation.

Figure 2 presents monthly rates of assaults against women per 1000 residents. The variation between months ranges from 10 to 72. Average monthly assaults fell from 48 during the 2 years before the new law to 25 assaults in the 3 years after it.

The regression results for assaults against women are summarized in Table 3. Separate columns display results for models with and without a linear time trend. The effect of the closing-time law was negative in both analyses, which suggests that this law resulted in decreased rates of assaults. However, this effect was only significant in the model that did not control for the underlying time trend. The simulation at the bottom of the table estimates the effect of the law on the number of assaults in Diadema during the 36 months after implementation. The model without time controls suggests that the law prevented 1051 assaults (95% confidence interval [CI]=680, 1421) between July 2002 and July 2005 (a reduction of 56% from predicted assaults without the intervention). The model with linear time trends, however, estimated an insignificant reduction of 176 assaults (a 17% drop; 95% CI=−239, 590) following the law.

Table 2 also suggests that assault rates were positively related to regional unemployment rates, although this result was not significant in models that controlled for time trends. As was the case for homicides, the autocorrelation coefficients for assaults were significant in the uncorrected first-stage regressions but were not significantly different from the zero in the second stage. This indicates that the Prais–Winsten correction adequately controlled for the first-order serial correlation.

The bottom section of Table 3 shows estimates for the effect of the law on the number of assaults in Diadema during the 36 months after implementation. We calculated these figures using the regression coefficients to simulate the number of assaults that would be expected each month under the alternative assumptions of the new law occurring or not.

DISCUSSION

From our analyses, we were able to conclude that closing bars at 11 PM was related to a large and statistically significant reduction in homicides—almost 9 murders a month in a city of 360 000 residents—an annual reduction of 106 or 30 per 100 000 population. This is a considerable public health achievement, especially in a country with such a high level of violent deaths.

However, the current analyses have some limitations. Inadequate local data meant we could not control for some demographic, social, and economic changes that may be related to crime rates. To account for such changes in our models, we controlled for underlying time trends. Data limitations also meant that during this period we could not compare Diadema crime rates directly to those of neighboring communities. Death certificate data can be used to study homicides throughout Brazil but are less useful for local analyses because they identify location of residence rather than where deaths occur.[19] Comparisons with crime counts from law enforcement agencies in nearby cities may be feasible using annual data, but such analyses would not be possible until more postlaw data are available from these communities. These data would give future researchers the ability to better measure the effect of restrictions on drinking hours.

In a related issue, we could not investigate whether the reduction in homicides in Diadema was related to displacement of violent crime to neighboring communities. One effect of the law may be that individuals who were heavy drinkers or predisposed to violence relocated to nearby communities with less-regulated drinking venues. To the extent that such displacement occurred, the law would not have reduced problems so much as moved them to these other communities. However, there is limited empirical support for such displacement effects and, in fact, some support for diffusion of crime reduction benefits across neighborhoods.[20,21] But this should be further researched as additional data become available.

Our findings regarding assaults on women were weaker than our homicide results, possibly because of the shorter time-series of

TABLE 2—Results of Linear Regression Analyses for Homicides: Diadema, Brazil, January 1995–July 2005

	January and July 2000 Controls[a]		No 2000 Intervention Controls[b]	
	No Time Trend	Linear Time Trend	No Time Trend	Linear Time Trend
Intercept, r (*t*)	−3.151*** (−9.762)	−4.510 (−0.036)	−2.876*** (—8.018)	153.469** (2.788)
Linear time trend, years (*t*)		0.001 (0.011)		−0.079** (−2.840)
January 2000 intervention, r (*t*)	−0.256 (−1.588)	−0.257 (−1.335)		
July 2000 intervention, r (*t*)	−0.046 (−0.278)	−0.047 (−0.247)		
Gun control law, r (*t*)	−0.541*** (−3.960)	−0.543** (−2.593)	−0.612*** (−3.934)	−0.351* (−2.231)
Unemployment rate, % (*t*)	0.035* (1.802)	0.035 (0.907)	0.013 (0.622)	0.071** (2.613)
New closing-time law, r (*t*)	−0.578*** (−4.937)	−0.579*** (−4.185)	−0.720*** (−6.027)	−0.504*** (−3.944)
ρ (*t*)	0.245** (2.840)	0.245** (2.842)	0.337*** (4.022)	0.234** (2.700)
Simulation of impact of new law				
Homicides prevented in 3 years, no.	318.2	318.8	426.6	267.3
Homicides prevented, %	43.9	44.0	51.3	39.6
95% Lower bound on homicides prevented	211.4	192.6	309.4	155.0
95% Upper bound on homicides prevented	425.0	445.0	543.9	379.6

Note. Linear regression analyses related log-transformed homicide rates per 1000 population to untransformed exogenous measures using monthly data (N = 127 months). Models included generalized least squares correction for first-order autocorrelated residuals (Prais–Winsten estimator). The 2006 gun law and closing law interventions were coded as dummy variables.
[a]The first 2 columns control for the 2002 previous enforcement changes. Within each of these pairs of columns, the first column does not control for underlying trends, whereas the second includes the linear time trend to control for unmeasured factors that may have influenced homicide rates.
[b]The last 2 columns exclude controls for the 2002 previous enforcement changes. Within each of these pairs of columns, the first column does not control for underlying trends, whereas the second includes the linear time trend to control for unmeasured factors that may have influenced homicide rates.
*P < .05; **P < .01; ***P < .001 (2-tailed tests)

available data. This, combined with the variability of the monthly data, made it difficult to distinguish a reduction caused by the new law from underlying trends or from random noise. Thus, although the data were consistent with a sizeable reduction in assaults against women, we are less certain that this effect was a result of the new law.

These findings have significant public health implications. Between 1980 and 2004, the murder rate in Brazil more than doubled, from just over 11 to 27 per 100 000 per year.[22,23] By comparison, the World Health Organization estimates that in 2000, the homicide rates per 100 000 population were 1 for the United Kingdom, 6 for the United States, and 27 for Brazil.[24] There are about 130 gun-related deaths a day in Brazil,[23] and in 2002, homicide was the leading cause of death for people aged 15 to 44 years.[22] Although the murder rate is now falling,[25] probably as a result of various government initiatives including the 2004 gun law,[18] the overall rate is so high that, given the relation between alcohol and violence, the effect of the new closing-time law is important and shows that alcohol-related violence can be reduced. Interestingly, the mayor of Diadema was re-elected in 2004, and opinion polls suggested increased popularity as a result of the new law, the opposite of what he had feared. When he proposed the law he was criticized by bar owners who said it would increase unemployment.

Given Diadema's poor socioeconomic conditions and high baseline rate of violence, we would not expect such a dramatic effect of a closing-time law to generalize to all cultures or countries. Nevertheless, these results are consistent with the literature that links alcohol

TABLE 3—Results of Linear Regression Analyses for Assaults Against Women: Diadema, Brazil, July 2000–July 2005

	No Time Trend	Linear Time Trend
Intercept, r (*t*)	−3.402** (−2.985)	484.459** (2.882)
Linear time trend, years (*t*)		−0.244** (−2.903)
Unemployment rate, % (*t*)	0.075 (1.181)	0.057 (1.060)
New closing time law, r (*t*)	−0.822*** (−4.737)	−0.189 (−0.709)
ρ (*t*)	0.416*** (3.544)	0.304* (2.476)
R^2	0.487	0.581
Simulation impact of new law		
Assaults prevented in 3 years, no.	1050.6	175.8
Assaults prevented, %	56.1	17.2
95% Lower bound on assaults prevented	680.0	−238.6
95% Upper bound on assaults prevented	1421.2	590.2

Note. Linear regression analyses related log-transformed crime rates per 1000 population to untransformed exogenous measures using monthly data from July 2000 to July 2005 (N = 61 months). Models included generalized least squares correction for first-order autocorrelated residuals (Prais—Winsten algorithm). The new closing time law was coded as a dummy variable.
*P < .05; **P < .01; ***P < .001 (2-tailed tests).

availability and violence,[25] strongly support restrictions on drinking hours as a public health measure, and give no support to the converse view that increasing availability will somehow reduce problems.[26–29] ■

About the Authors

Sergio Duailibi, Ilana Pinsky, and Ronaldo Laranjeira are with Unidade de Pesquisa em Álcool e outras Drogas (UNIAD), Departamento de Psiquiatria, Universidade Federal de São Paulo, São Paulo, Brazil. William Ponicki and Joel Grube are with the Prevention Research Center, Pacific Institute for Research and Evaluation, Berkeley, Calif. Martin Raw is with the Division of Epidemiology and Public Health, University of Nottingham, Nottingham, England.

Requests for reprints should be sent to Sergio Duailibi, Rua Machado Bitencourt nº 300, apto113, Vila Clementino, CEP 04044–000, São Paulo, Brazil (e-mail: duailibi@uol.com.br).

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Contributors

S. Duailibi originated the study concept and design, contributed project planning, data collection, and assisted with the first draft of the article. W. Ponicki and J. Grube assisted with the project design and planning, data analysis, and in drafting the article. I. Pinsky assisted with the original study concept and design, project planning and management, data collection, and the first draft of the article. R. Laranjeira participated in the project management, planning, original study concept and design, data collection, and the final draft of the article. M. Raw contributed data interpretation and preparation of the final article.

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Human Participant Protection

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