

UPDATE: INTERNATIONAL REPORT

Reductions In Firearm-Related Mortality And Hospitalizations In Brazil After Gun Control

More than 5,000 gun-related deaths in 2004 may have been prevented by the passage of Brazil's gun control laws in 2003.

by **Maria de Fátima Marinho de Souza, James Macinko, Airlane Pereira Alencar, Deborah Carvalho Malta, and Otaliba Libânio de Moraes Neto**

ABSTRACT: This paper provides evidence suggesting that gun control measures have been effective in reducing the toll of violence on population health in Brazil. In 2004, for the first time in more than a decade, firearm-related mortality declined 8 percent from the previous year. Firearm-related hospitalizations also reversed a historical trend that year by decreasing 4.6 percent from 2003 levels. These changes corresponded with anti-gun legislation passed in late 2003 and disarmament campaigns undertaken throughout the country since mid-2004. The estimated impact of these measures, if they prove causal, could be as much as 5,563 firearm-related deaths averted in 2004 alone. [*Health Affairs* 26, no. 2 (2007): 575–584; 10.1377/hlthaff.26.2.575]

BRAZIL is well known as having one of the world's highest homicide rates. Figures from the World Health Organization (WHO) suggest that as many as 45,000 Brazilians are murdered each year—approximately one person every twelve minutes.¹ Homicide is the leading cause of death for men ages 15–44; 90 percent of homicides in this age group involve firearms.² Population rates for firearm deaths are estimated at 21.72 per

100,000 in 2002. In comparison, there were 29,237, or 10.7 per 100,000, firearm-related homicides in the United States that same year.³

In October 2003 the Brazilian government passed a new set of laws to reduce gun-related violence.⁴ These measures sought to control the flow of firearms into the country, made it illegal to own guns that are not registered or to carry guns outside of one's home or business, instituted background checks for gun pur-

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chases, and raised the minimum age for gun purchase to twenty-five.⁵ National legislation also imposed new penalties, including fines and tougher prison sentences, for people found in violation of these laws. In July 2004 additional measures took place, including a countrywide voluntary disarmament program.⁶ These programs continue to this day. This paper presents preliminary evidence of the effectiveness of these measures in reducing deaths and hospitalizations attributable to firearms in Brazil.

Study Data And Methods

For this study, we used data from the Brazilian Ministry of Health's vital statistics system.⁷ Deaths and hospitalizations due to firearms were analyzed from Chapter XX (external causes of morbidity and mortality) of the *International Classification of Diseases, Tenth Revision* (ICD-10).⁸ We present data both as counts and as population-adjusted rates.⁹

This study takes advantage of a natural experiment, since the two national interventions intended to control gun availability were implemented at two different time periods after nearly a decade of increasing mortality and hospitalization rates because of firearms. The first 2004 observation took place after the gun control measures were implemented in October 2003; the second took place after the voluntary arms buy-back program was implemented in July 2004, which, according to official figures, resulted in more than 450,000 guns turned in to the federal police at participating churches.¹⁰

To analyze the impact of the legislation on firearm mortality, we used a linear time-series regression approach to model the best-fitting mortality line based on the historical time series built from observations from each of Brazil's twenty-seven federative units (twenty-six states and the federal district) for each six-month period between 1996 and 2004 (18 observations for all 27 federative units = 486 total observations). The equation of this line was used to predict values and 95 percent confidence intervals for 2004/2005. Predicted values were then compared with observed val-

ues for the same period.¹¹ We analyzed city-specific rates using the same approach, but we used only the capital city of each state as the unit of analysis.

Data on hospitalizations were taken from the Hospital Information System (SIH) database.¹² Analyses of predicted hospitalizations used a linear regression approach similar to that used to model mortality trends. However, data consisted of quarterly observations, and the unit of analysis was the region rather than the state because some states are small and did not have stable estimates over the short period of time studied. The final model allowed each region to have its own intercept and used a total of five regions times six quarters, for a total of thirty observations.

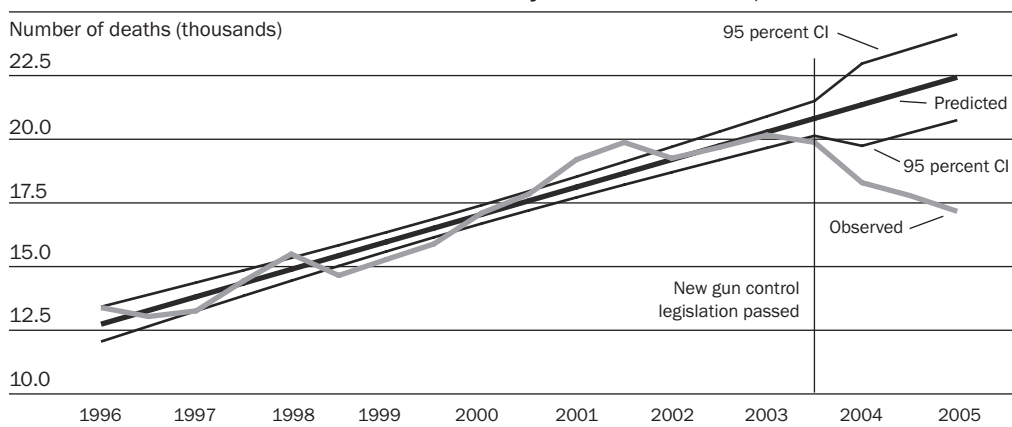
Predicted deaths and hospitalizations for 2004 can be thought of as the counterfactual condition: what would have happened had the gun control interventions never taken place. Because there have been no other sudden nationwide changes in other aspects of mortality or hospitalization or other artifactual explanations that would affect the entire country (such as changes in death/disease categorization or in billing practices) reported over this time period, we interpreted the difference between the observed and predicted values as the impact of the interventions.

Finally, for the analyses of firearm-related hospitalizations for the states of São Paulo, Rio de Janeiro, and Espírito Santo, we calculated the ratio of the number of hospitalizations in each month in each state to that occurring in the same month of the previous year. Monthly observations were used to control for seasonality effects. A positive number means that the hospitalization rate was higher than that of the previous year; a negative number, that it was lower.

Study Results

■ Firearm-related mortality declines.

Exhibit 1 shows the number of deaths by firearms for each six-month period between 1996 and 2005. The exhibit clearly shows that beginning in the first months of 2004, the historical increase in firearm homicides halted; fire-

EXHIBIT 1**Observed And Predicted Number Of Deaths By Firearms In Brazil, 1996–2005**

SOURCE: Ministry of Health of Brazil, April 2006.

NOTES: Predicted values calculated by linear regression based on data from each half-year for the period 1996–2003. Observed values include data from 1996–2005. CI is confidence interval.

arm homicides actually decreased 8.2 percent from 2003 levels. Observed values were 15.4 percent lower than expected levels for the same time period.

Brazil is composed of five main regions (the poorest North and Northeast, the more wealthy Southeast and South, and the mixed Central-West). Within these regions there are twenty-six states and one federal district (Brasília). Exhibit 2 shows the number of firearm deaths broken down by region and state. Every region except the North shows a decline in deaths, ranging from a 2.1 percent decrease in the South to a 20.1 percent decrease in the Southeast. In some states, such as São Paulo, Mato Grosso, Sergipe, and Paraíba, the yearly decrease was at or above 30 percent. All but six states showed significantly lower-than-expected values. In these six states (Amazonas, Amapá, Pará, and Roraima in the North; Espírito Santo in the Southeast; and Paraná in the South) the rate of increase in homicides was higher than expected. The marked increase in firearm deaths in Amazonas and Pará is largely responsible for the net increase in the North region. Exhibit 2 also shows the absolute difference between observed and predicted values. This figure can be thought of as the total number of lives saved, given the interventions. For 2004, as many as 5,563 potential

deaths from firearms were averted.

When analyses were restricted to include only the capital city of each state, a similar pattern emerged. Although the capital cities contain only about 24 percent of the population, they were the site of nearly 40 percent of firearm-related deaths. During the first six months of 2004, firearm deaths decreased 10.9 percent (Exhibit 3). This was lower than the national average of 12.5 percent; however, adjusting for population size, the net decrease was 3.4 per 100,000, slightly higher than the national average of 3.1 per 100,000. There was also considerable variation ranging from reductions of 40 percent in Palmas to increases of 50 percent in São Luís. During the second half of 2004 (after implementation of the voluntary disarmament programs), mortality in capital cities fell to 22.2 percent lower than predicted, a larger decrease than for the country as a whole (18.4 percent).

Our work led us to examine the weapons used for homicide. More than 70 percent of homicides in both years were committed using firearms. The total number of firearm-related homicides decreased 8.9 percent, by 3,200 deaths, from 2003 to 2004. Use of knives or other penetrating objects decreased 2.3 percent. The use of blunt objects increased 4.5 percent, and the use of physical force increased

EXHIBIT 2

Number Of Firearm Homicides In Brazil, Observed Versus Predicted Values, By Region And State, 2004

State	Obs.	Pred.	Difference: observed-predicted		
			Absolute change	Per 100,000	Percent change
Acre	60	72	-12	-1.9	-19.2
Amazonas	255	194	61	2.0	23.8
Amapá	75	69	6	1.1	8.4
Pará	1,031	966	65	1.0	6.3
Rondônia	370	446	-76	-5.2	-20.6
Roraima	46	41	5	1.3	10.1
Tocantins	117	144	-27	-2.1	-23.0
North region total	1,954	1,932	22	0.2	1.1
Alagoas	765	893	-128	-4.4	-16.8
Bahia	2,229	2,448	-219	-1.6	-9.8
Ceará	899	978	-79	-1.0	-8.7
Maranhão	360	397	-37	-0.6	-10.2
Paraíba	399	532	-133	-3.8	-33.4
Pernambuco	3,278	3,850	-572	-6.9	-17.5
Piauí	183	228	-45	1.5	-24.7
Rio Grande do Norte	368	368	0	0.0	0.0
Sergipe	309	426	-117	-6.2	-37.9
Northeast region total	8,790	10,121	-1,331	-2.7	-15.1
Espírito Santo	1,215	1,190	25	0.8	2.1
Minas Gerais	3,185	3,244	-59	-0.3	-1.9
Rio de Janeiro	6,157	7,025	-868	-5.8	-14.1
São Paulo	8,146	11,011	-2,865	-7.3	-35.2
Southeast region total	18,703	22,470	-3,767	-4.9	-20.1
Paraná	2,078	2,042	36	0.4	1.7
Rio Grande do Sul	1,735	1,792	-57	-0.5	-3.3
Santa Catarina	447	515	-68	-1.2	-15.2
South region total	4,260	4,348	-88	-0.3	-2.1
Distrito Federal	600	653	-53	-2.4	-8.9
Goiás	879	938	-59	-1.1	-6.7
Mato Grosso do Sul	413	508	-95	-4.3	-23.0
Mato Grosso	520	712	-192	-7.1	-36.8
Central-West region total	2,412	2,811	-399	-3.2	-16.6
Brazil total	36,119	41,682	-5,563	-3.1	-15.4

SOURCE: Brazilian Mortality Information System (SIM), April 2006.

* Predicted values calculated by linear regression based on data from each half-year for the period 1996–2003.

by 5.7 percent over 2003 levels. The category “other and nonspecified” also decreased significantly from 2003 levels.¹³

■ **A parallel drop in hospitalizations.** In 2003 there were 21,329 hospitalizations for firearms in Brazil. This number was 20,352 in 2004—a 4.6 percent decline. This decline took place in the context of a tendency for overall hospitalization rates to increase or remain stable in most states.

Hospitalizations due to firearms fell primarily as a result of decreased hospitalizations

for firearm-related unintentional injuries (13 percent decline) and attempted suicides with a firearm (18 percent decline). By age group, intentional injuries declined most of all in men ages 15–39, averaging about 16 percent lower than in 2003. In 2004 intentional injuries accounted for almost 29 percent of firearm-related hospitalizations, and assault accounted for 65 percent. Comparing 2003 with 2004, hospitalizations due to assault with a firearm fell only 0.2 percent.¹⁴

Regional variations in firearm-related hos-

EXHIBIT 3**Number Of Firearm Homicides In Brazil, Observed Versus Predicted Values, By State Capital, 2004**

State	Capital city	Obs.	Pred. ^a	Difference: observed-predicted		
				Absolute change	Per 100,000	Percent change
Acre	Rio Branco	40	44	-4	-1.3	-8.3
Amapá	Macapá	50	38	12	3.6	31.6
Amazônia	Manaus	200	150	50	3.2	33.4
Pará	Belém	258	232	26	1.9	11.4
Rondônia	Porto Velho	138	160	-22	-6.2	-14.0
Roraima	Boa Vista	32	32	0	-0.1	-0.7
Tocantins	Palmas	20	33	-13	-7.3	-40.1
Alagoas	Maceió	414	358	56	6.5	15.8
Bahia	Salvador	870	852	18	0.7	2.2
Ceará	Fortaleza	384	398	-14	-0.6	-3.5
Maranhão	São Luís	130	86	44	4.7	50.8
Paraíba	João Pessoa	169	217	-48	-7.5	-22.1
Pernambuco	Recife	873	927	-54	-3.7	-5.8
Piauí	Teresina	91	104	-13	-1.7	-12.7
Rio Grande do Norte	Natal	170	131	39	5.2	30.2
Sergipe	Aracaju	124	168	-44	-9.1	-26.3
Espírito Santo	Vitória	158	147	11	3.6	7.6
Minas Gerais	Belo Horizonte	1,127	929	198	8.5	21.3
Rio de Janeiro	Rio de Janeiro	2,456	2,733	-277	-4.6	-10.1
São Paulo	São Paulo	2,824	4,320	-1,496	-13.9	-34.6
Paraná	Curitiba	473	402	71	4.2	17.8
Rio Grande do Sul	Porto Alegre	401	383	18	1.3	4.6
Santa Catarina	Florianópolis	93	88	5	1.3	5.5
Distrito Federal	Brasília	522	549	-27	-1.2	-4.9
Goiás	Goiânia	256	259	-3	-0.2	-1.1
Mato Grosso	Cuiabá	167	236	-69	-13.4	-29.2
Mato Grosso do Sul	Campo Grande	152	156	-4	-0.5	-2.4
Total		12,592	14,130	-1,538	-3.6	-10.9

SOURCE: Brazilian Mortality Information System (SIM), October 2006.

NOTE: States are ordered alphabetically by region; regions are provided in Exhibit 2.

^a Predicted values calculated by linear regression based on data from each half-year for the period 1996–2003.

pitalization present a somewhat different pattern than mortality rates. Every region except the South and Northeast experienced lower hospitalization rates for firearms in 2004 compared with 2003. All regions except the South had fewer observed values than predicted, however (Exhibit 4).

■ **Variations by state.** Although the overall levels of firearm-related deaths and hospitalizations for the country decreased greatly in 2004, there were important differences in the geography and potential mechanisms of this change. We examine three high-crime states (São Paulo, Rio de Janeiro, Espírito Santo) to

illustrate how the impact of federal gun control policies varied at the local level and how these variations correspond with different patterns of changes in hospitalization rates for firearm-related causes.

São Paulo. São Paulo (in the Southeast region) contains thirty-nine million people and has one of the country's highest rates of gun violence. It is known to have strictly enforced gun control laws (rates of arrest for firearm possession in 2004 were 50 per 100,000—20 percent higher than the national average of 40 per 100,000) and has vigorously promoted disarmament programs. This resulted in one of

EXHIBIT 4**Observed And Predicted Hospitalizations For Firearms In Brazil, By Region, 2003–2004**

Region	2003		2004			Difference: observed–predicted
	Total (observed)	Percent change from previous year	Total (observed)	Percent change from previous year	Total predicted ^a	
North	959	–3.0	923	–3.8	971	–48
Northeast	5,049	18.6	5,187	2.7	5,825	–638
Southeast	11,855	8.7	10,691	–9.8	12,362	–1,671
South	1,944	2.3	2,203	13.3	2,013	190
Central West	1,522	10.6	1,348	–11.4	1,631	–283
Brazil total	21,329	9.8	20,352	–4.6	22,802	–2,450

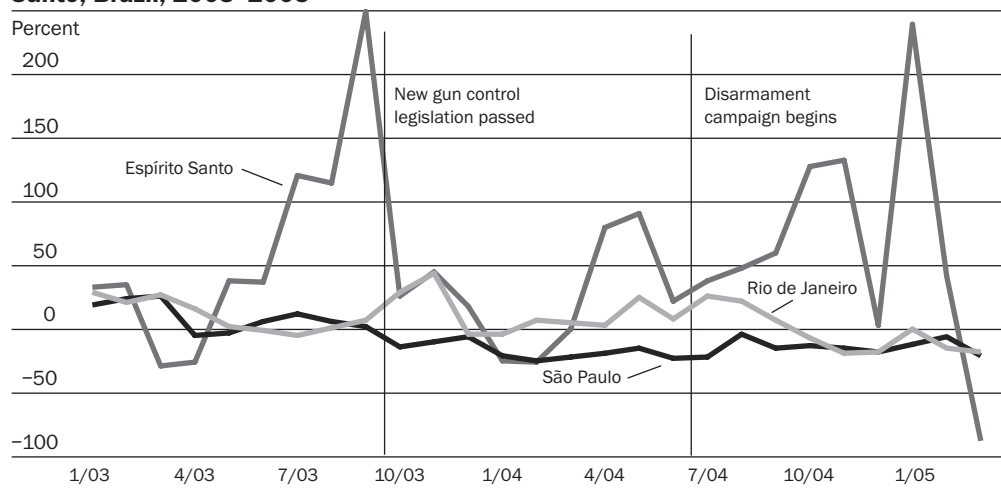
SOURCE: Brazilian Hospital Information System (SIH), April 2006.

^a Predicted values calculated by linear regression based on data from each semester since 2002, the earliest period for which reliable and complete state-level data were available.

the highest rates of gun buy-back in the country: 188.8 per 100,000. Firearm-related hospitalizations (measured as percentage change from the number occurring in the same month of the previous year) began to decrease in late 2003 corresponding with introduction of anti-gun legislation (Exhibit 5). After the gun buy-back programs, hospitalizations decreased a further 10 percent. The average number of hospitalizations was 470 during January–August

2004 and 423 during September/October 2003–March 2005. Thus, in this state, enforcement of new laws corresponded with a decrease in firearm-related hospitalizations. The buy-back programs in 2004 corresponded with an accelerated decline, resulting in average hospitalization rates that were about 15 percent lower than in years prior to these policy changes.

Rio de Janeiro. Rio de Janeiro is the third-larg-

EXHIBIT 5**Percentage Change In The Number Of Firearm-Related Hospitalizations From The Same Month In The Previous Year, States Of São Paulo, Rio de Janeiro, And Espírito Santo, Brazil, 2003–2005**

SOURCE: Ministry of Health of Brazil, April 2006.

est state in Brazil, with fifteen million inhabitants, and it borders São Paulo. Rio is well known as having a weak law enforcement infrastructure, evidenced by some of the country's most pervasive levels of drug trafficking and violent crime.¹⁵ Overall rates of incarceration for firearm possession did not greatly increase in Rio during 2004–05, and rates of arrest for firearm possession (30 per 100,000) were 25 percent lower than the national average. However, federal and local authorities heavily supported disarmament efforts in Rio, and the state averaged firearm buy-back rates of 193.2 per 100,000. There was a dip in hospitalizations after October 2003, but rates returned to higher levels than in previous years (Exhibit 5). After the buy-back programs were implemented, however, rates fell about 12 percent and stayed below 2003/04 levels. The average number of firearm-related hospitalizations per month was 179 between June and August 2004, and 157 between September 2004 and March 2005. In the case of Rio, it seems that weaker (or less consistent) enforcement of legislation did not greatly affect hospitalizations, while disarmament campaigns corresponded with major, sustained decline.

Espírito Santo. Espírito Santo has three million inhabitants and is also located in the Southeast, just north of Rio de Janeiro and east of São Paulo. Historically, it has had one of Brazil's highest mortality rates as a result of violence (47.8 per 100,000). Like Rio, it also has a limited law enforcement infrastructure (rates of arrest for firearm possession in 2004 were 20 per 100,000—only half the national average), which is reflected in high rates of violent crime related to drug trafficking.¹⁶ Hospitalizations actually increased dramatically after the gun control laws took effect and continued to vary at levels up to three times higher than those of the previous year (Exhibit 5). Espírito

Santo had very low levels of arms buy-back, collecting only 85.9 per 100,000 population. This is reflected in the overall increase of hospitalizations after the gun buy-back programs began. In Espírito Santo, where neither program was well implemented, there seems to have been an increase in firearm-related hospitalizations.

Conclusions And Policy Implications

“In Brazil a good portion of recent declines in firearm-related deaths and hospitalizations could reasonably be attributed to new government measures aimed at reducing the availability of guns.”

This paper is intended to stimulate further debate over whether regulation of firearms can be an effective strategy in reducing deaths attributable to gun-related violence. In Brazil it appears that a good portion of recent declines in firearm-related deaths and hospitalizations could reasonably be attributed to new government measures aimed at reducing the availability of guns. If the laws had not been passed, based on projections from the

data collected during the previous decade, the expected number of deaths in 2004 should have been 41,682. This suggests that gun control measures implemented in 2003 and 2004 might have averted as many as 5,563 deaths in 2004 alone.

This finding is further supported by our analysis of hospitalizations for firearms. There appear to be two distinct effects: an early and smaller-magnitude effect that happened after the anti-gun legislation was implemented in late 2003, and a later effect that happened after implementation of the disarmament campaigns in the second half of 2004. Interestingly, much of the reduction in hospitalizations took place for unintentional and self-inflicted injuries—precisely the indicators that would be expected to have been most affected by a voluntary program.¹⁷ Examination of variations by state also demonstrated the important synergistic effect of both gun control actions.

Several anomalies require further discus-

sion. First, some parts of Brazil did not see a decrease in firearm-related mortality. Some regions (especially in the North) are not representative of the rest of the country, in that they are sparsely populated and would thus be expected to have considerable difficulty implementing any firearm control measures. For example, the state of Amazonas is, fittingly, in the Amazon jungle. Many populations are accessible only by plane or boat, there are few urban centers and thus few means of enforcing gun control laws, and there are protracted conflicts over property rights that often result in violence. These reasons might help explain the low rates of gun buy-back in this region (70.4 per 100,000).¹⁸ Second, cause-specific mortality rates might not be stable in the small populations encountered in many northern states, which account for less than 7 percent of all of Brazil's firearm deaths. Random fluctuations in the very small number of firearm deaths in these states from year to year could mask changes in overall trends over time.

Because of the ecologic nature of this study, confounding factors, such as improvements in the economy, might explain these secular changes. However, in Brazil, income distribution rather than absolute income levels has been correlated with increased rates of homicide; although real wages have increased somewhat over 2003 levels, income inequality has increased dramatically over the same time period.¹⁹ Moreover, declines seen in firearm-related mortality were significant and sustained for more than one year. They took place after legislation intended to reduce the availability of firearms in the general population, and there were no other major activities that might explain the rapid and sustained drop in deaths from this one cause in almost every city and state in the country.²⁰

There is some skepticism whether gun laws can be effective even in richer industrialized countries.²¹ For example, in Canada there is continued debate over the registration of handguns despite evidence showing decreases in some death rates.²² International evidence seems to suggest that at the very least, reduced availability of firearms is associated with

lower suicide rates.²³

There is surprisingly little evidence on the effectiveness of gun control in developing countries. In Colombia a ban on carrying firearms on weekends after paydays, on holidays, and on election days showed a 13–14 percent decline in homicides in cities with high levels of violent crime.²⁴ In Brazil there had been similar laws banning the possession of unregistered handguns. However, these policies were not widely or consistently enforced. The variation in effectiveness of the new measures regionally and in different metropolitan areas shows that expected policy impacts are likely to differ depending on the geography and demographics, political commitment, and overall climate of that city or municipality.

In spite of the early promise of gun control on outcomes, in October 2005 Brazilians overwhelmingly rejected a ban on firearms. According to one observer, “Nearly 65 percent of Brazilians voted to defend a right that only 1 percent of them exercise.”²⁵ Some have suggested that the referendum was impeded by the lobbying effort of U.S.-based advocacy organizations, which after the first round of legislation passed in 2003 spent considerable time providing strategic advice to pro-gun lobbies in Brazil.²⁶ The effectiveness of these efforts could be seen in increased pro-firearm advertising and reshaping the firearm debate from one of safety to one of civil rights—a discourse pervasive in the United States but previously unheard-of in Brazil. Nevertheless, the results of this study suggest that even in the absence of legislation altogether banning firearms, tougher gun laws coupled with mobilization of civil society have made a difference in reducing gun-related violence in Brazil.

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NOTES

1. Pan American Health Organization, "Statistics on Homicides, Suicides, Accidents, Injuries, and Attitudes towards Violence," 2005, <http://www.paho.org/English/AD/DPC/NC/violence-graphs.htm> (accessed 13 December 2006).
2. E. Krug et al., *World Report on Violence and Health* (Geneva: World Health Organization, 2002); and M.F. Peres and P.C. dos Santos, "Trends of Homicide Death in Brazil in the 90s: The Role of Firearms" (in Spanish), *Revista de Saúde Pública* 39, no. 1 (2005): 58–66.
3. Centers for Disease Control and Prevention, "Web-Based Injury Statistics Query and Reporting System (WISQARS)," 2006, <http://www.cdc.gov/ncipc/wisqars> (accessed 13 December 2006).
4. The Brazilian Senate approved a gun control bill in September 2003, Congress approved it in October, and the president signed it into law in December (Law 10826 of 22 December 2003). Nevertheless, most states chose to implement portions of the act in October using the final text approved by Congress.
5. Government of Brazil, "Lei no 10.826" (Law number 10.826, in Portuguese), 22 December 2003, <https://legislacao.planalto.gov.br/legislacao/nf/0/6EBCB3394FA8BBC183257268004DA122?OpenDocument&seq=1> (accessed 19 January 2007).
6. Brazilian Ministry of Justice, "Referendum on Arms Collection" (in Portuguese), <http://www.mj.gov.br/seguranca/desarmamento.htm> (accessed 19 January 2007).
7. Causes of death were obtained from the 2005 release of the Mortality Information System (Sistema de Informação sobre Mortalidade, or SIM), and hospitalization data came from the national Hospital Information System (Sistema de Informação Hospitalar, or SIH).
8. Codes W32–W34 include accidental death or injury by handguns, rifles, shotguns, and other firearms; codes X72–X74 include intentional self-harm with firearms; codes X93–X95 include assault by firearms; and codes Y22–Y24 include firearm injuries and deaths due to undetermined intent. The Brazilian Ministry of Health estimates that the SIM reliably captures more than 90 percent of deaths for the country as a whole. The SIH captures all hospitalizations in the country except for those paid for by private health insurance. Only about 20 percent of the population has private insurance, and this does not preclude them from using the public system. The level of underreporting of deaths as a result of violence is likely to be lower than for other causes of death, since all deaths suspected to be due to violence are confirmed by the Medical Legal Institute. See Brazilian Ministry of Health, *Health Brazil 2005: A Health Situation Analysis* (in Portuguese), 2006, http://portal.saude.gov.br/portal/arquivos/pdf/saude_brasil_2005.pdf (accessed 13 December 2006).
9. All rates are calculated using inter-census-year population counts. Brazilian Institute of Geography and Statistics, *Population Estimated by Age, 2004* (in Portuguese) (Rio de Janeiro: Ministry of Planning, 2004).
10. Brazilian Ministry of Justice, "Learn More about the Disarmament Campaign" (in Portuguese), <http://www.mj.gov.br/noticias/2005/Junho/rls220605saiba.htm> (accessed 10 March 2006).
11. An ordinary least squares (OLS) regression model resulted in the best fit with the data. Sensitivity tests using Poisson regression yielded similar results, and squared or log-transformed models did not significantly improve the fit. Adjustment for other variables (such as sex and age) was not possible given the small population of some states. Given the short time series involved (less than six years), it is unlikely that major changes among states would have occurred for these variables.
12. Analysis of hospitalizations used data only from 2002 onward, since prior to that the SIH included primary diagnosis only. So, for example, in the case of having a broken leg due to a gunshot wound, the SIH would have listed only "fractured tibia." As of January 2002, the Ministry of Health required hospitals to list a second diagnostic code in the case of all external causes.
13. A table showing these findings is available in an online technical appendix at <http://content.healthaffairs.org/cgi/content/full/26/2/575/DC1>.
14. Ibid.
15. Ministry of Justice and National Secretariat of Public Security, *Profile of Public Security Organizations, Volume I: Profile of State and Municipal Organizations* (in Portuguese), March 2006, <http://www.mj.gov.br/senasp/estatisticas/organiza%EF%F5es%20estaduais%20e%20municipais.pdf> (accessed 19 January 2007).
16. "Criminosos queimam ônibus em Vitória, Espírito Santo (Criminals burn bus in Vitória, Espírito Santo)," *Estadão*, 2 March 2006.

17. Similar reductions in suicide rates have been noted in Canada and New Zealand. See A.L. Beautrais, D.M. Fergusson, and L.J. Horwood, "Firearms Legislation and Reductions in Firearm-Related Suicide Deaths in New Zealand," *Australia New Zealand Journal of Psychiatry* 40, no. 3 (2006): 253–259.
18. Between 2004 and 2005, thirteen Brazilian states reported a major decline (3–48 percent) in the number of reported cases of illegal gun ownership, five states reported no change, and nine states showed increases (12–139 percent). All of those with increases were in the North and Northeast regions. Ministry of Justice and National Secretariat of Public Security, "Analysis of Information and Development of Public Safety Personnel" (in Portuguese), http://www.mj.gov.br/senasp/Institucional/inst_dep_dpadr.htm (accessed 31 October 2006).
19. R.B. Barradas and M.C. Ribeiro, "Correlation between Homicide Rates and Economic Indicators in São Paulo, Brazil, 1996" (in Portuguese), *Revista Panamericana de Salud Pública* 7, no. 2 (2000): 118–124; and Brazilian Institute of Geography and Statistics, "Monthly Employment Survey 2006" (in Portuguese), http://www.ibge.gov.br/home/estatistica/indicadores/trabalhoerendimento/pme_nova/default.shtm (accessed 15 May 2006).
20. Deaths from external causes such as car crashes remained the same or increased in some states during this time period. All-cause mortality in Brazil continued its overall decline, but there was no marked acceleration in 2003/04. In fact, several states' all-cause mortality did not decline significantly for black or mixed race populations (who have a higher risk of dying from firearm-related violence than do whites). See Ministry of Health, *Health Brazil 2005*, http://portal.saude.gov.br/portal/arquivos/pdf/saude_brasil_2005.pdf (accessed 29 October 2006).
21. For example, contrast J.R. Lott, *More Guns, Less Crime: Understanding Crime and Gun Control Laws* (Chicago: University of Chicago Press, 1998); with M. Duggan, "More Guns, More Crime," *Journal of Political Economy* 109, no. 5 (2001): 1086–1114.
22. A.A. Leenaars et al., "The Impact of Gun Control (Bill C-51) on Suicide in Canada," *Death Studies* 27 no. 2 (2003): 103–124.
23. V. Ajdacic-Gross et al., "Changing Times: A Longitudinal Analysis of International Firearm Suicide Data," *American Journal of Public Health* 96, no. 10 (2006): 1752–1755. See also D.W. Webster et al., "Association between Youth-Focused Firearm Laws and Youth Suicides," *Journal of the American Medical Association* 292, no. 5 (2004): 594–601.
24. A. Villaveces et al., "Effect of a Ban on Carrying Firearms on Homicide Rates in Two Colombian Cities," *Journal of the American Medical Association* 283, no. 9 (2000): 1205–1209.
25. D. Morton, "Gunning for the World," *Foreign Policy* 152 (2006): 58–67. See also T. Phillips, "Brazil Votes on Deadly Obsession with Guns," *Guardian*, 22 October 2005.
26. Several analysts suggest that the international gun lobby felt threatened by the proposed referendum in Brazil and took steps to mobilize its Brazilian counterparts. See K. Hearn, "As Brazil Votes to Ban Guns, NRA Joins the Fight," *Nation*, 21 October 2005; and Morton, "Gunning for the World."