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Firearm availability and homicide: A review of the literature

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Abstract

This article reviews the most commonly cited, representative, empirical studies in the peer-reviewed literature that directly investigate the association of gun availability and homicide victimization. Individual-level studies ($n=4$) are reviewed that investigate the risks and benefits of owning a personal or household firearm. The research suggests that households with firearms are at higher risk for homicide, and there is no net beneficial effect of firearm ownership. No longitudinal cohort study seems to have investigated the association between a gun in the home and homicide. Two groups of ecological studies are reviewed, those comparing multiple countries and those focused solely on the United States. Results from the cross-sectional international studies ($n=7$) typically show that in high-income countries with more firearms, both men and women are at higher risk for homicide, particularly firearm homicide. Time series ($n=10$) and cross-sectional studies ($n=9$) of U.S. cities, states, and regions and for the United States as a whole, generally find a statistically significant gun prevalence–homicide association. None of the studies prove causation, but the available evidence is consistent with the hypothesis that increased gun prevalence increases the homicide rate.

Keywords: Firearm; Firearms; Homicide; Guns

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1. Introduction

1.1. Homicide

In the past 35 years, homicide rates in the United States have moved in cycles. The rate of homicide victimization doubled from the mid-1960s to the late 1970s. After peaking in 1980 at a rate of 10.2/100,000, it fell to 7.9 in 1985. The rate rose again and peaked at 9.8 in 1991 and then declined to a low of 5.7 in 1999 (Federal Bureau of Investigation, 2002). Between 1985 and 1991, the nonfirearm homicide rate remained relatively stable, while the firearm homicide rate increased significantly, thus accounting for the changes in the overall homicide rate. The recent reductions in the overall homicide rate have been attributed to reductions in firearm homicides in large cities—the same areas responsible for a large proportion of the increase in the overall firearm homicide rate during the preceding rise. Stratified analysis of homicide victimization rates for youth and young adults reveals that these groups were primarily responsible for the dramatic increase in firearm homicide rates during the mid-1980s to the early 1990s. Researchers attribute the recent decline in homicide to different causes, including reduced unemployment, increased policing, and the decline and stabilization of the illegal drug markets (Wintemute, 2000).

The gender and race of victims and offenders have not changed significantly over time. Males commit approximately 90% of all homicides and represent 75% of the victims. African Americans are disproportionately represented among homicide victims and offenders. Prior to 1985, 25- to 34-year olds experienced the highest homicide victimization rates; however, after 1985, 18- to 24-year olds have had the highest rates of homicide victimization (Federal Bureau of Investigation, 2002).

The homicide rate is higher in urban than in rural areas (Federal Bureau of Investigation, 2002). Homicide rates have been consistently higher in the Southern and Western regions of the United States. This is especially true for firearm homicides (Fox & Zawitz, 2000). Most researchers believe these regional differences are a result of cultural differences and higher gun ownership levels (Messner & Rosenfeld, 1999).

1.1.1. The weapon effect

Over 60% of all homicides in the United States in 1999 involved a firearm (Federal Bureau of Investigation, 2002). Differences in the lethality of the weapons used in criminal acts have been described as the "weapon instrumentality effects" (Cook, 1991; Zimring, 1968). The theory is that, for a given level of intent, firearms are more lethal when used during assaults and robberies compared to other weapons such as knives. Zimring (1991) suggests that firearms allow the assailant to kill without sustained effort and allow a weaker person to attack a stronger victim in a way that may not be physically possible with another weapon.

1.2. Firearm availability

Firearm ownership in the United States, and particularly handgun ownership, is much more common than in other developed nations. From their national survey, Cook and Ludwig

(1997) estimated that, in 1996, 44 million Americans owned 192 million firearms. Of these firearms, 65 million were handguns. Approximately 75% of gun owners reported owning more than one gun. Many more men than women owned guns, and ownership was highest in rural areas.

In 2000, it was estimated that 32% of American households owned at least one firearm. This number has declined from 51% in 1977. Although the number of firearms owned by individuals increased during this same time period and the percentage of individuals owning firearms remained relatively constant, changing household demographics has led to the decline in the household ownership figure. In the past 30 years, the number of households with an adult male has fallen significantly (Smith, 2000).

1.2.1. Measurement of firearm availability

Neither most states nor the federal government has reporting requirements for firearm sales or ownership. Gun ownership rates have generally been estimated through surveys, such as the General Social Survey (GSS) or some state-level Behavioral Risk Factor Surveys (BRFSS). The results of the GSS are representative of the nation and the nine census regions but not of individual states (Davis & Smith, 1998).

Researchers, therefore, have generally been forced to develop proxies to measure ownership levels at the state or city levels. Usually, these proxies are validated by comparing them to a survey data.

Cook (1979) developed a well-known proxy for city gun prevalence. To investigate the relationship between gun prevalence and robbery rates in cities, he used the average of the percent of homicides involving a gun and the percent of suicides involving a gun to estimate gun ownership. Often referred to as "Cook's index," this proxy has been used in several other studies (Hemenway & Miller, 2000; Miller, Azrael, & Hemenway, 2001; Sloan et al., 1988). Other proxies for gun ownership levels have included the number of hunting licenses per capita (Krug, 1967), subscriptions to *Gun and Ammo* magazine (Duggan, 2001; Lester, 1988), the percent of robberies and other crimes in which guns are used (Kleck, 1984; McDowall, 1991), and the number of handgun purchase licenses (Bordura, 1986; Fisher, 1976; Newton & Zimring, 1969). Some researchers have attempted to create factor scores of multiple measures of prevalence (Kleck & Patterson, 1993; Seitz, 1972). Additional measures have included the percent of suicides by firearm (Azrael, Cook, & Miller, 2001; Hemenway & Miller, 2000; Hemenway, Shinoda-Tagawa, & Miller, 2002; Miller et al., 2001; Miller, Azrael, & Hemenway, 2002a, 2002b, 2002c), the accumulated number of new firearms manufactured in the United States(Kleck, 1979, 1984), and the rate of firearm accidents (Lester, 1988).

Recent research has attempted to determine which proxy measures most accurately measure gun ownership. Azrael et al. (2001) evaluated several proxies by comparing them to survey data. The proxies included the percent of suicides committed by firearm (FS/S), the percent of homicides committed by firearm (FH/H), Cook's index, the unintentional firearm death rate, subscription rates to *Guns and Ammo* magazine, and the number of National Rifle Association members per capita. They found that FS/S produced the most consistent results when compared with multiple survey-based estimates of gun ownership at the county, state, and regional levels.

Even when measured accurately, household gun ownership levels are not an ideal measure of firearm availability. The percentage of households with a firearm tells us nothing about the average number of firearms in each of those households or how lethal and concealable the guns are. Nor does it tell anything directly about how easy it is for high-risk users, such as teenagers or criminals, to obtain guns. For example, in the United States, guns move easily across state lines. Teens and criminals in states with few guns and strict gun laws can readily obtain firearms that were originally purchased in states with many firearms and lax gun regulations (Bureau of Alcohol Tobacco and Firearms, 1999). Nonetheless, most research uses household gun or handgun ownership levels as the "gold standard" for estimates of gun availability.

1.3. The relationship of firearm prevalence to homicide rates

There are various theories that predict a negative relationship between household firearm ownership and homicide. A prime reason for gun ownership is protection. If a gun in the home often deters or thwarts assaults and violent robberies, we might expect to find that households with firearms had lower homicide victimization rates.

Greater gun availability in the community could also reduce homicide. Citizens could use their guns both to protect themselves and to protect their neighbors against the criminal element. We might thus expect to find lower rates of homicide in communities where guns were more available.

Areas with high levels of crime and homicide, particularly gun homicide, might create a demand for public policies that try to reduce the number of firearms available to criminals and others. Strict gun control laws might reduce the levels of gun ownership and homicides could either fall somewhat (or stay unchanged or rise), but homicide rates might still be high relative to low crime or rural areas. Comparisons across geographic areas might find that areas with high homicide rates had lower levels of gun ownership.

On the other hand, there are reasons to expect a positive relationship between firearm ownership levels and homicide rates. Higher availability of firearms could lead to higher homicide rates if there is a greater use of guns in robberies and criminal assaults, making these encounters more lethal. The ready availability of firearms could also contribute to the escalation of the level of violence in arguments or disputes. Having a gun could embolden individuals to take risks, to engage in activities, or go places that they might otherwise avoid because they were too dangerous. We might also expect a positive relationship between firearm ownership levels and homicide rates if high homicide rates in an area lead households to arm themselves for protection.

The relationship between firearm availability and homicide can clearly be bidirectional. For example, high levels of firearm availability might lead to higher homicide rates, and higher homicide rates may lead to more people acquiring firearms. Some of the studies reviewed in this article directly address this issue (Duggan, 2001; Kleck & Patterson, 1993; Magaddino & Medoff, 1984). Also, firearm regulations can directly affect both gun availability and homicide rates, and both firearm ownership levels and homicide rates may influence whether or not firearm regulations are enacted. For example, firearm regulations

may cause fewer individuals to acquire firearms, and as a result of low levels of gun ownership, passing further restrictive laws may meet less political resistance.

This article does not address research that has investigated the relationship between firearm regulations and homicide. Nor do we claim to review every study examining the association of firearm availability and homicide. In addition, we do not discuss related studies that provide indirect evidence on the relationship between firearm availability and homicide (e.g., Do criminals who assault with knives have different levels of lethal intent than those who use guns). Rather, this article provides a review of the most commonly cited, representative, and empirical studies in the peer-reviewed literature that directly investigate the association between gun availability and homicide.

The first section describes individual case control and cohort studies. The second section describes international ecological studies that have compared the United States to other countries. The third section describes ecological studies of the United States that have contrasted the levels of gun availability and homicide across regions, states, and rural and urban areas.

None of the studies can prove causation. They merely examine the statistical association between gun availability and homicide. They provide evidence on whether or not the real world is consistent with various theories. The actual hypothesis that is usually tested is that there is no statistical association between gun availability and homicide (the "null" hypotheses). The issue is whether this hypothesis can be rejected with a high degree of confidence, and if so whether the direction of the association is positive or negative.

2. Individual-level studies

The case control and cohort studies discussed below provide information about the benefits and risks associated with owning a personal or household gun. They do not provide information about whether community levels of gun ownership affect the household risk of homicide.

2.1. Case control studies

In one of the most cited studies, Kellerman et al. (1993) used a case control study involving three counties in three states—Tennessee, Washington, and Ohio—to evaluate the risks or benefits associated with keeping a firearm in the home. The study identified all homicides involving residents age 13 and older that occurred in the home of the victim over a 5-year period. To obtain information about the victims, proxies were selected through law enforcement interviews, newspaper accounts, obituaries, and calls to funeral homes.

Controls were selected and matched to the case subject by age, race, sex, and neighborhood. A total of 316 matched pairs of cases and controls were included in the final analysis. Case subjects were similar to controls except that they were more likely to rent their homes and to have lived alone.

Sixty-three percent of the victims were men and 37% were women. Most victims (77%) were killed by an intimate, relative, friend, or acquaintance. Only 4% were killed by a stranger. Half died from gunshot wounds. The majority of homicides (55%) occurred in the context of an altercation or quarrel, as part of a romantic triangle, or a murder–suicide. In only 14% of the cases was there evidence of forced entry.

The variables that were included in the final conditional logistic regression model were strongly and independently associated with an increased risk of homicide: home rented, living alone, any household member ever hit or hurt in a fight in the home, any household member ever arrested, any household member used illicit drugs, and the presence of one or more guns in the home.

Handguns were kept in 36% of case households compared to 23% of control households. Gun ownership was most strongly associated with an increased risk of homicide by a family member or intimate acquaintance (OR = 7.8, 95% CI = 2.6–23.2) The overall association of firearm ownership and homicide in the home was 2.7 (95% CI = 1.6–4.4).

The authors report the major possible limitations of the study. Using proxy respondents may increase the possibility of recall bias. There is also the possibility of underreporting of gun ownership by controls, particularly in the case of illegal ownership. A pilot study, however, had confirmed that gun ownership reporting, at least the reporting of legal guns, was generally valid.

The generalizability of this study is limited to homicides occurring in the home and particularly in urban counties. While the authors control for many variables, others could influence the relationship (e.g., if people who are more psychologically prone to violence keep guns at home). The possibility of reverse causation (if the gun was acquired because of a specific threat of harm to the victim) could not be eliminated. Finally, there was no evidence presented about whether a gun from the home was actually used in any of the homicides.

The findings from the stratified analysis were consistent with the notion that a gun in the home increased the risk of homicide. The link between gun ownership and homicide was due entirely to the strong association between gun ownership and homicide by firearm; homicide by other means was not associated with having a gun in the home. Gun ownership was most strongly associated with homicide at the hand of a family member or intimate acquaintance; guns were not significantly linked to an increased risk of homicide by friends, intruders, or strangers. In addition, there was no evidence of a protective effect of keeping a gun in the home, even for the small subgroup of cases that involved a force entry.

In a subgroup analysis of homicide victims identified in the case control study conducted by Kellerman et al. (1993) in Tennessee, Washington, and Ohio, Bailey et al. (1997) attempted to determine risk factors for violent death for women in the home. There were 143 female homicide victims during the 5-year period. Firearms were involved in 46% of the homicides and 82% of victims were killed by someone they knew. Independent risk factors for homicide of women in the home included living alone, illicit drug use by a member of the household, prior domestic violence in the household, prior arrest of a household member, and having one or more guns in the home. A gun in the home was associated with a large, independent increased risk of female homicide victimization (OR = 4.6, 95% CI = 1.2–17.5).

This subanalysis has all the strengths and weaknesses of the full Kellerman et al. (1993) study. It suggests that a gun in the home may increase the risk of homicide victimization for women more than for men. This result is consistent with the fact that compared to men, a higher percentage of women are murdered in the home and by an intimate partner (Federal Bureau of Investigation, 2002).

In another case control study, Cummings, Koepsell, Grossman, Savarino, and Thompson (1997) attempted to determine whether the purchase of a handgun from a licensed dealer was associated with an increased risk of homicide in any location, and whether this association varied in relation to the time since the purchase.

The study sample was identified through a large Health Maintenance Organization (HMO) in Seattle, WA. Case subjects were HMO members who died as a result of homicide between 1980 and 1992. Controls were HMO members matched to the cases on age, sex, and neighborhood or zip code. Two principal categories of handgun purchase were examined: personal purchase and family member purchase.

Over the 12-year study period, there were 117 homicides in which 56% involved a firearm. For 22% of homicide victims, compared to 12% of controls, a family member had purchased a handgun. The relative risk of death by homicide for individuals with a family handgun purchase was 2.2 (95% CI = 1.3–3.7). The relative risk of death by homicides with a personal handgun purchase was also 2.2. There was no statistically significant association between time of purchase of a handgun and the risk of homicide. Indeed, no victim in this study was murdered with a gun within 5 years of any firearm handgun purchase. There was, however, an increased risk for homicide as the number of handguns purchased increased.

The study did not control for potential differences between cases and controls (other than those due to the matching), such as psychological history, substance abuse, criminal history, and previous household violence. For example, if handgun purchasers are more inclined to live in a more dangerous environment or have violent personalities, it might confound the observed relationship. Also, the proxy for handgun ownership, purchase from a licensed dealer in Washington, did not allow for verification if the subjects still owned handguns or identify guns acquired previously or from other sources. The authors report, however, that the household gun prevalence in their study was similar to the prevalence numbers indicated from a prior Seattle gun ownership survey. In addition, using dealer records of sale rather than self-reported ownership eliminated the problem of recall bias.

2.2. Cohort studies

Wintemute, Parham, Beaumont, Wright, and Drake (1999) conducted a population-based cohort study of over 235,000 individuals who purchased a handgun in California in 1991 from a licensed dealer. Purchasers were followed through December 1996. The main outcome measure was the standardized mortality ratio (SMR)—a ratio of deaths among the study population compared to the number expected based on age- and sex-specific rates among adults in California. The California Department of Justice provided records of handgun purchasers and death certificate data.

After adjusting for age, homicide by firearm up to 6 years after the purchase accounted for fewer deaths than expected among male handgun purchasers (SMR = 0.79) and more deaths among women than expected (SMR = 2.01). Wintemute (2000) explains that the subjects in the study population were legal handgun purchasers who had passed criminal history background checks and therefore had fewer risk factors for death by homicide. For women who are at higher risk for homicide by intimate partners, however, purchasers of a handgun were at higher risk. It was not known if the handguns purchased were the ones involved in the violent death.

2.3. Summary of individual-level studies

Most striking is the paucity of individual-level studies of this contentious and important issue. For example, there are no studies that follow a large cohort of individuals with known characteristics, comparing homicide victimization rates of those with a gun in the home, and those without. Wintemute et al. (1999) come closest, but that study could not account for other characteristics of the individuals since their data sources lacked information on important possible confounders (e.g., alcohol consumption, arrests, income). That study, like the Bailey, Kellerman, et al. (1997) case control investigation, suggests that a gun in the home may be especially problematic for women.

There are only two case control studies and they have various and different limitations. Nonetheless, the results are suggestive. Individuals in households with guns in the home appear at markedly higher risk for homicide victimization, especially from family, intimates, and acquaintances. However, whether this relationship is causal is not as clear. One contending hypothesis that has not been eliminated is one of reverse causation—that individuals at risk for homicide may obtain firearms, and the firearms do not lower the individual's risk to an average level. Cummings et al. (1997) suggest that any such risk is a long-term rather than a short-term risk for the risk of homicide victimization did not fall with time since purchase. Another contending hypothesis is that the same types of individuals or families who obtain firearms are also those who generally place themselves at higher risk for homicide (e.g., risk prone individuals). There is evidence from studies of high-school and college students, and of adult gun carriers, that individuals who carry guns are more prone to binge drink and to act aggressively and inappropriately (Bailey, Flewelling, & Rosenbaum, 1997; Cunningham, Henggeler, Limber, Melton, & Nation, 2000; DuRant, Kahn, Beckford, & Woods, 1997; Miller, Hemenway, & Wechsler, 1999; Valois, McKeown, Garrison, & Vincent, 1995). Of course, these are precisely the kind of individuals society would least want to have firearms.

It is apparent how a gun in the home could be a risk factor for suicide or for unintentional firearm fatality. For homicide victimization, a gun in the home could also be used against residents (e.g., spouse killing). But none of the case control studies provide evidence whether the gun in the home was actually used in the homicide. A gun in the home might increase risk-taking by residents, making them less likely to remove themselves from dangerous situations. A gun could make arguments and altercations more lethal. A gun in the home could also increase the likelihood of gun carrying outside the home, which could have deadly

effects. Guns can clearly be protective, but the case control and cohort studies find little evidence of a NET beneficial effect.

3. Ecological studies

A key element in case control, cohort, and ecological studies is to account for possible important confounders that affect the relationship between the variable of interest and the outcome; in this case, firearm availability and homicide. Generally, an important first step is to compare likes to likes. For case control studies, that means matching on, at least, age, gender, and neighborhood. For international studies, that means comparing high-income countries to high-income countries, thus helping to hold constant many socioeconomic variables. In U.S. ecological studies, it means comparing states to states, cities to cities, and rural areas to rural areas.

3.1. International studies

Several ecological studies have compared homicide rates across high-income countries. The first group reviewed here compares gun prevalence and violence rates in the United States to many countries. The second group presents two studies that directly compare the United States to Canada. These studies are all cross sectional in nature, making inferences about causality difficult.

A serious problem with international data involves the quality and comparability of the data. Often, collection and reporting practices are not uniform across countries as a result of different surveillance systems and definitions. The use of proxies to represent firearm availability may vary in terms of quality as well. Finally, cultural differences that are related to firearm use and ownership, as well as levels of violence, are difficult to incorporate accurately into association models. Given the lack of data or poor data quality from most medium-income and low-income countries, it is necessary to focus attention on the high-income world.

Killias (1993a) performed some of the initial international research that attempted to determine the relationship between levels of household gun ownership and homicide rates. His first study evaluated rates of violence in 14 developed countries: eleven in Europe, along with the United States, Canada, and Australia. He used data from the International Crime Survey of 1989, a telephone survey of 14 countries, representing 28,000 respondents, to measure firearm prevalence. The respondents were asked whether there were any firearms in their household, and if so whether any were a handgun or a long gun. The respondents from Switzerland were asked whether the gun was a private or military firearm.

There was substantial variation in the proportion of the population owning firearms from 2% (Netherlands) to 48% (United States). Northern Ireland was removed from the study due to a high number of deaths from explosives, and guns kept for military purposes were removed from Switzerland's prevalence numbers.

The association between firearm ownership and homicide was statistically significant. There was no statistically significant correlation between ownership and nonfirearm homi-

cide. As the author acknowledges, the study included a small number of countries, and the data on homicide were collected prior to the information about gun ownership. However, since ownership levels change slowly, it is reasonable to interpret the results as showing a positive relationship between gun ownership and homicide. The study, however, contained no control variables.

In a follow-up study, Killias (1993b) supplemented the data from the 1989 International Crime Survey with data from the 1992 survey. Four additional countries were included—the Czech Republic, Italy, New Zealand, and Sweden—to increase the number of countries to 18. As in the first study, the analysis was conducted with and without the outliers of the United States and Northern Ireland.

The results confirmed the earlier study utilizing 14 countries. The correlation between gun ownership and the overall homicide rate was .61 (down to .48 when the United States and Northern Ireland were excluded). The correlation between nongun homicide rate and gun ownership was less strong (.47, down to .21 when the United States and Northern Ireland were excluded). The limitations in this study were the same as the earlier research.

A third study by Killias, van Kesteren, and Rindlisbacher (2001) incorporated data from the International Crime Surveys of 1989, 1992, and 1996. The addition of Estonia, Malta, and Austria in 1996 brought the total number of countries in the survey to 21. In this study, homicide was disaggregated by gender.

Results from the bivariate correlations did not demonstrate significant correlations between firearm ownership and homicide, overall or for men or women independently. The difference between this and the earlier results was largely due to the inclusion of Estonia, which had high homicide rates and low levels of household gun ownership. The homicide rate of Estonia and the Czech Republic had skyrocketed after the breakup of the Soviet Union in 1989.

A study by Hemenway and Miller (2000) took an approach similar to Killias et al. (2001). However, rather than rely on a convenience sample of countries that had undertaken household surveys and to ensure greater comparability of economic and social conditions, they focused solely on high-income countries, as defined by the World Bank. The study included 26 high-income nations with populations greater than 1 million people. To measure gun availability, the authors used two proxies, the percent of suicides with a firearm (FS/S) and Cook's index.

The correlation coefficient for gun availability and homicide across the 26 countries using the FS/S measure was .69 and using Cook's index it was .74. Both results were highly statistically significant. When the United States was removed, the association remained significant when using Cook's index—which was strongly associated with the firearm homicide rate, but not with the nonfirearm homicide rate. When the countries were weighted to account for the differences in population, the association between firearm availability and homicide increased.

No control variables were included in the analysis. However, by including only high-income nations, some of the differences in socioeconomic status of nations that may affect levels of lethal violence could be controlled.

In a follow-up study, Hemenway et al. (2002) examined female homicide rates cross nationally, using countries with more than 2 million residents classified as high income by the World Bank. A total of 25 countries were included in the study. Homicide rates for firearm and nonfirearm means were acquired from the World Health Organization for the most recent year for which data were available (1994–1999).

The authors used the percent of suicides committed with a firearm (FS/S) as the proxy for firearm ownership in each country. Urbanization and income inequality were included as control variables.

The United States was an outlier for both firearm ownership levels and female homicide. The United States accounted for 70% of all female homicide victims in the study. The U.S. female homicide rate was five times higher than that of all of the other countries combined; its firearm homicide rate was 11 times higher.

Firearm availability was significantly associated with the female homicide rate only when the United States was included in the analysis (r=.71). However, if the data were weighted by populations, even with the United States excluded, firearm ownership levels were significantly associated with overall homicide victimization rates of women. The results from the multivariate analyses confirmed the results of the bivariate approach.

The differences among the Hemenway and Miller (2000), Hemenway et al. (2002), and Killias et al. (2001) results were not due to the different measures of gun ownership levels. Instead, they were due entirely to the specific countries included in the analysis. If the three non-high-income countries (Estonia, Malta, and the Czech Republic) are excluded from the Killias et al. analysis, the results for the 18 remaining high-income countries are the same whether FS/S or Killias' survey data are used as the measure of gun availability. And those results are virtually identical to the Hemenway and Miller (2000) and Hemenway et al. (2002) results that use all 25 or 26 populous high-income countries.

3.1.1. United States and Canada

Some researchers have studied the differences in homicide between the United States and Canada. These two countries share many similarities in terms of socioeconomics, language, and culture but differ in terms of firearm levels and regulation.

Sloan et al. (1988) compared two cities: Seattle, Washington and Vancouver, British Columbia. These nearby cities are similar in terms geography, climate, history, and the socioeconomic status of the inhabitants, but they have slightly different ethnic compositions. A main difference between the two cities is handgun regulation and prevalence. Two separate measures of firearm prevalence were used: (1) the number of restricted weapons permits issued by the Vancouver police between March 1984 and 1988 compared to the number of concealed weapons permits issued in Seattle during the same time period, and (2) Cook's index. The measures indicated that firearm ownership was much higher in Seattle than Vancouver (41% vs. 12%).

The authors identified all homicides in both cities from January 1, 1980, through December 21, 1986; there were 388 homicides in Seattle and 204 in Vancouver. The relative risk of being a victim of homicide in Seattle compared to Vancouver was 1.6 (95% CI = 1.3–2.1). The risk ratio of homicide by firearm in Seattle compared to Vancouver was 5.1 (95% CI = 3.5–7.3); the

risk of homicide by a nonfirearm weapon was not statistically significant. Comparing only two cities limits the generalizability of this study; however, the general similarities of the two places provide fairly good control of many possible confounding factors.

In another U.S.–Canadian comparison study, Centerwall (1991) compared the homicide rates in several northern U.S. states with the Canadian provinces they bordered. To estimate firearm ownership in the United States, the author used a 1978 national household survey by Wright, Rossi, and Daly (1983) that allowed state-level estimation for 39 states—but unfortunately not for Maine, New Hampshire, Idaho, or Alaska. For the Canadian figures, he used a 1976 Canadian Department of Justice survey that estimated firearm ownership for certain provinces but not the Yukon or Northwest Territories. These surveys indicated that there were 4–10 times as many handguns per 1000 persons in the U.S. states for which data were available compared to the adjoining Canadian provinces. The prevalence of long guns was approximately the same in the two countries.

The average rates of criminal homicide from 1976 to 1980 were compared by state, city, and province. Many factors were similar in the border states and the adjoining provinces including geography, climate, industry, ethnicity (after major metropolitan areas were removed), and per capita income.

Rates of criminal homicide in adjacent states and provinces with and without major metropolitan areas (e.g., Detroit and New York City) were presented; however, the author did not include information on statistical significance. The author claimed that there was no distinct pattern of homicide related to firearm availability and concluded that "major differences in the prevalence of handguns have not resulted in differing total criminal homicide rates in Canadian provinces and adjoining U.S. states."

In pairwise comparisons, however, for four Canadian provinces (including Ontario with a population of 8.8 million people, Alberta with 2.3 million, and British Columbia with 2.8 million), the homicide rates appear substantially lower in Canada than their neighboring American states; for two provinces, the homicides rates are similar to their U.S. neighbors, and for two, the Canadian homicide rates are higher (the Yukon, with a population of 0.024 million, and Manitoba, population about 1 million). Centerwall did not compare the overall Canadian homicide rate for his eight provinces with the overall U.S. homicide rate for the adjacent U.S. states. When that is done, the Canadian rate is 2.8 per 100,000 compared to 8.5 per 100,000 for the United States. In other words, the U.S. homicide rate is three times higher. Excluding all the major cities in these U.S. states (i.e., New York City, Buffalo, Detroit, Minneapolis, and Seattle) lowers the U.S. rate to 3.6 per 100,000, still 20% higher than the Canadian rate.

3.2. Summary of international studies

The data show that, compared to other high-income countries, the United States has a terrible homicide problem. This is especially true for gun homicides. Studies show that U.S. children (Centers for Disease Control and Prevention, 1997), women, and men are all much higher risk of homicide compared to individuals living in other high-income countries (Krug, Powell, & Dahlberg, 1998).

The international data show a strong association of firearm availability with firearm homicide, but not with nonfirearm homicide. The relationship of firearm availability with overall homicide rates is also strong—as long as the United States is included in the analysis. Excluding the United States, the association is always positive but often nonsignificant. Even if the true association between firearm availability and homicide was causal, this finding would not be unexpected. High-income countries outside the United States have much lower rates of handgun ownership than the United States, and the licensing, registration, and safe storage regulations they have make it much harder for known criminals to obtain firearms. Thus, relatively few of the homicides in these countries are firearm homicides. Reducing the number further could not have a large effect on their overall homicide rate, and studies might not have the statistical power to detect it.

The U.S.–Canadian comparisons are of interest, but for Sloan et al. (1988), the number of observations is really only two; Centerwall (1991) demonstrates that northern U.S. cities have far higher homicide rates than Canadian cities in adjacent provinces.

A major problem with the international studies is that they hold few if any other factors constant that could affect homicide rates. Of course, given the relatively small number of high-income countries, it would not be statistically possible to include very many confounders.

3.3. U.S. studies

Numerous ecological studies have examined the relationship between firearm availability and homicide in the United States across regions, states, cities, and counties. The studies have used various proxy measures of firearm prevalence including, among others, FS/S, Cook's index, and measures of firearm sporting magazine subscriptions. The first set of research presented here is time series designs, the second group is cross-sectional studies.

3.3.1. Time series: cities and states

Newton and Zimring (1969) investigated the association between firearm ownership and homicide in Detroit. The authors measured the general trend of lawful firearm ownership through handgun permit-to-purchase records from 1965 through 1968. Over the 4 years, the number of handgun permits continually increased so that by 1968, the number of handgun permits granted was approximately four times the number in 1965. During this time, homicides also increased. Nonfirearm homicides increased 30% while firearm homicides increased 400%. In 1965, 39% of homicides involved firearms and by 1968, 72% of homicides involved firearms.

Fisher (1976) also examined the role of firearm availability in homicides in Detroit, incorporating data from 1963 to 1971. He measured firearm availability by the number of handguns registered in Detroit and the number of licenses to purchase handguns that were granted each year by Detroit police. Long gun ownership was not measured.

Fisher (1976) used a regression model with the annual number of homicides as the dependent variable and handgun availability as the key independent variable of interest. He controlled for the percent of homicides cleared by arrest, the number of full-time police, the

percent of the labor force unemployed, the number of manufacturing workers employed, the accidental death and assault rates, and other demographic characteristics of the population. Handgun availability was a significant independent predictor of the overall homicide rate.

Over the study period, the number of homicides involving handguns increased sevenfold. Homicide by nonfirearm weapons increased at a much slower rate. The author asserts that if murder rates were independent of the weapon used, then all types of homicide would have increased equally over time. As with other studies of a single city, the study is limited by its sample size and generalizability to other places.

In another study of Detroit, McDowall (1991) used data from 1951 to 1986 and measured firearm availability using an index composed of the proportion of robberies in Detroit committed with a gun and the proportion of suicides committed with a gun.

To account for reverse causation, McDowall (1991) used a two-stage least squares regression model. Independent variables included the proportion of the population that was non-White, the proportion age 15–24, the homicide clearance rate lagged by one year, and the number of robberies per 100,000 residents. McDowall also adjusted for the time period after the 1976 Detroit riots that are assumed to have permanently increased the city's firearm density. The gun density index was treated as an endogenous variable.

Results of the model indicated that an increase in the gun density index was associated with an increase in Detroit's homicide rate. To determine if the results were sensitive to alternative measures of gun density, McDowall (1991) used the annual number of licenses-to-purchase handguns in Detroit, a measure only of new purchases of legal handguns. The results using this measure produced similar results of a positive and statistically significant association between gun density and homicide in Detroit.

Sorenson and Berk (2001) analyzed the relationship between handgun sales and homicide after accounting for beer sales, unemployment, migration, racial composition, and cohort size. Using data from California for 22 years, 1972–1993, the researchers found that the prior years dealer sales of handguns were significantly linked to homicides for virtually every age group of Black, Hispanic, and White males. There was no association with female homicides. The association of handgun sales with homicide was stronger for younger than for older males and was more closely related to firearm homicides than to all homicides. The association was substantial. If causative, the results suggest that almost 5000 fewer 15- to 34-year-old male Californians would have died during this period if handgun sales had remained at the 1972 levels. The authors acknowledge that sales data are somewhat crude measures of the variables of interest and that a 1-year lag of the independent variables may not be the appropriate time frame. Their results, however, are consistent across gender, age, and ethnic groups.

3.3.2. Time series: national

In a national time series model of homicide rates from 1951 through 1968, Phillips, Votey, and Howell (1976) evaluated the relationship of handgun availability, deterrence, and socioeconomic factors to homicide. A per capita handgun density measure was created using gun stock data previously compiled by Newton and Zimring (1969).

In their two-stage least squares regression model, where handgun density was treated as an exogenous variable, the authors found that controlling for the clearance rate and additional socioeconomic factors, handgun density was positively related to the homicide rate. According to their model, a 10% reduction in handgun density would result in a 27% reduction in the homicide offense rate.

Kleck (1979) examined the relationship between firearm availability and homicide rates over time for the United States as a whole. The first study looked at the years 1947–1973. A per capita gun ownership figure was derived by taking the annual totals of firearms manufactured by U.S. companies for private sale in the United States plus the number of imported firearms, divided by the resident population for each year. This measure does not account for the losses of firearms over time.

Kleck (1979) used a two-stage least squares regression model to evaluate the relationship between firearm availability and homicide rates because of the assumed reciprocal relationships between gun ownership and homicide rates. Additional control variables were also included in the models. The results indicated that homicide rates were positively associated with gun prevalence, and the reciprocal association was also positive that homicide rates influenced gun ownership.

In a follow-up study, Kleck (1984) reanalyzed the data extending the study through 1978 and adding additional covariates. He used a four equation simultaneous model, and in this analysis, he found that homicide rates affected gun ownership but gun ownership did not affect homicide rates. This latter result was due entirely to the inclusion of robbery rates as a control variable. Robbery rates and homicide rates are very highly correlated. Without the robbery variable, gun ownership was positively and significantly related to homicide.

In a multipart analysis, Magaddino and Medoff (1984) looked at the relationship between firearm laws and crime rates at the state and national level. In order to address the question whether firearm availability influenced crime rates as well as firearm laws, the authors included a measure of annual purchases of new firearms by the civilian population of the United States and the cumulative number of new handguns per capita in various structural models of homicide rates evaluated over 30 years (1947–1977). In general, the authors found that yearly handgun purchases were not significantly related to increases in homicide rates; however, the cumulative number of handguns available had a positive and statistically significant association with the homicide rate. In a two-stage regression analysis, the homicide rate was found to influence handgun purchases, implying that the homicide rate and handgun purchases are not simply one directional.

As part of his extensive research on concealed weapon laws, Lott (1998) found that increasing gun ownership in states reduced the homicide rate. Using data from two election exit polls conducted by news organization following the 1988 and 1996 presidential elections, the author reported that gun ownership increased over time, from 27.4% reporting ownership in 1988 to 37% in 1996. All other surveys find household gun ownership levels decreasing during this period. According to the Voter News Service, the organization responsible for conducting the polls, the data cannot be used to determine state-level gun ownership. The polls only surveyed actual voters, a minority of the adult population, the questions regarding

gun ownership changed between the two polls, and the sample size was too small for reliable state-level estimates.

In a study evaluating the association between gun availability and crime, Duggan (2001) used annual state- and county-level sales data of *Guns and Ammo* magazine, a popular magazine for firearm owners and enthusiasts, as a proxy for gun ownership. In validating this proxy, he found that this annual measure correlated highly with the annual firearm accident death rate as well as the annual number of gun shows per capita and NRA membership levels.

Duggan (2001) modeled the log of the homicide rate in each state year as the outcome variable and used the magazine sales rate, per capita personal income, unemployment rate, and percent of state's residents between 18 and 24 as independent variables. His model indicated that changes in gun ownership were significantly and positively related to changes in homicide rates and that this relationship was explained by the impact of firearm ownership on firearm homicide. He reported that a 10% increase in the rate of gun ownership was associated with an almost 2% increase in the overall homicide rate.

In a secondary analysis, Duggan (2001) explored the hypothesis that increases in crime rates lead to an increase in gun ownership. By running regression models that specified the lagged homicide rate as an independent variable and current gun ownership rates as the dependent variable, he found a slight positive relationship that, according to the author, indicated that increases in homicide may lead to an increase in gun ownership. When the relationship was reversed, an even stronger association was seen between lagged gun ownership rates and current homicide rates.

3.3.3. Cross-sectional studies

Bordura (1986) looked at homicide in Illinois' nine regions and 102 counties using two averaged measures of gun ownership. The principal measure came from the state of Illinois' computerized file of firearm owner identification (FOID) cards, which are required by the state for every handgun purchaser. The author averaged the annual number of cards issued over 8 years, 1973–1981. In addition, he used the results from 3 years (1976, 1977, and 1981) of a statewide survey of gun ownership to compile information about the types of guns (handguns or long guns) owned.

The author found that the rate of firearm ownership in both region and county analysis was negatively associated with all measures of violent crime, including overall homicide. The author did not control for differences in the counties, particularly the population density.

Instead of comparing Cook county (Chicago), which has few legal guns and many homicides, with downstate rural counties that have few homicides and many legal guns, the relevant comparison is among rural counties and among suburban counties. In a step in this direction, the author performed multivariate analyses, controlling for urbanization and population density as well as other factors, including the percent of female-headed households and the number of African Americans age 18–34 per capita. In these analyses, the results showed no association between overall firearm ownership and homicide. Interestingly, female firearm ownership was positively associated with homicide, suggesting that high homicide levels increased female ownership.

To explore the relationship between gun availability and robbery, Cook (1979) performed a cross-sectional analysis of 50 large cities in the United States. Using data on the number of robberies in 1975, he tested several regression models that included explanatory variables representing criminal justice system effectiveness, population density, and other regional and state differences. In addition, he created the measure of gun availability that has come to be known as "Cook's index."

Results of the regression models indicated that increased gun density had no impact on overall robbery rates, but that gun density was positively associated with the proportion of robberies that involved a gun. Cook suggests that this reflects a substitution of guns for other weapons in robberies in high gun density cities. Most relevant, he found that the per capita robbery murder rate was positively associated with increased gun density through an increased rate of gun robbery.

In study using 170 U.S. cities with populations of at least 100,000, Kleck and Patterson (1993) employed a two-stage least squares approach to model the average violence rates from 1979 to 1981, assuming that gun availability and violence have a simultaneous reciprocal relationship. They created a gun prevalence figure for each city using the results of a factor analysis of five measures including the percent of suicides, homicide, aggravated assault, and robbery with firearms and the "percentage of the dollar value of all stolen property reported to the police, which was due to firearms thefts." The authors included eight control variables (e.g., rates of poverty and divorce) and 19 additional gun control proxies. Using the factor score in the model, they found that gun prevalence did not have a statistically significant effect on homicide; however, the models suggest a positive association between rates of homicide and gun prevalence.

The analysis appears to have some problems. As a group, the 19 gun control variables are undoubtedly highly negatively correlated with the gun prevalence variable. Including all the gun-related variables in the equation lowers the likelihood of finding a significant effect of any. While the authors examine whether any single gun control variable has a statistically significant association with gun prevalence (few do), the real issue is whether or not they do as a group.

Another serious concern is with various authors' attempts to control for reverse causation. The first stage of a two-stage least squares model is crucial, providing an estimate of the gun levels that would have existed had there been no effect of homicide on gun ownership. This estimate requires the use of an "instrumental variable" that needs to meet three criteria: it need to be highly correlated with gun availability, have no direct effect on homicide, and have no correlation with other factors that are not in the model. In the Kleck and Patterson (1993) study, these requirements are not met by the instrument variables used: NRA membership, gun magazine subscriptions, and liberalism. For example, these variables are likely to be related to regional attitudes that are correlated with crime and homicide. The statistical tests to determine whether the instrument variables meet the necessary conditions are not reported (Alba & Messner, 1995).

In a study by Seitz (1972) using all 50 states, path coefficients were developed to evaluate the relationship among gun control laws, firearm availability, and White and non-White criminal homicide rates in 1967. Firearm accessibility was measured by performing a factor

analysis of firearm homicides, aggravated assaults, and firearm accidents and assigning factor scores to each of the 50 states based on these events.

Seitz (1972) found that firearm availability was positively associated with homicide rates for both Whites and non-Whites and gun control laws influenced firearm availability. Additional covariates possibly related to homicide and firearm prevalence were not included in this analysis.

In another cross-sectional study of the 50 states, Lester (1988) used vital statistics data from 1970 to test the association between homicide and four separate measures of firearm availability: the percent of suicides by firearm, unintentional firearm death rate, a strictness scale of firearm laws developed by the author, and the subscription rates for two popular firearm magazines, *Shooting Times* and *Guns and Ammo*. In a secondary analysis, he tested the association between firearm availability and firearm deaths at the regional level.

Lester (1988) reported a positive association using each of the four measures, between firearm availability and rates of firearm homicide at the state level. The associations with overall homicide produced mixed results depending on which measure was used for gun ownership. At the regional level, most of the measures of firearm ownership were positively and significantly correlated with firearm homicide rates.

Kaplan and Geling (1998) examined the regional variation in rates of firearm suicide compared to firearm homicide in the nine census regions. They conducted a stratified analysis by creating four groups—White male, White female, Black male, Black female—using data on deaths from 1989 through 1991. Gun availability was measured using the GSS data that ask respondents about household gun ownership.

The association between gun ownership and the proportion of homicides involving firearms was significant for females, both White and Black (r=.88 and r=.78) but not for males (r=.25 and r=.60). When the authors looked at the actual correlation between the rates of gun ownership and firearm homicide, they found significant positive associations for White and Black women (r=.68 and r=.62), but again the results, although positive, were not significant for men. Correlations between rates of gun ownership and nonfirearm homicide were not significant for any of the four groups. The authors did not report the associations for overall (firearm plus nonfirearm) homicide rates for any of the groups and no control variables were included.

Miller et al. (2002a, 2002b, 2002c) conducted a series of studies evaluating the relationship between levels of firearm ownership at the state and regional level and homicides for various age and gender groups. In their main study (Miller et al., 2002a), the authors used panel data from 1988 to 1997 for 50 states and nine regions to evaluate rates of homicide, firearm homicide, and nonfirearm homicide disaggregated by age. At the state level, they used the percent of suicides with a firearm as a proxy for ownership and measured gun availability at the regional level with data from the GSS on household gun ownership.

Using a negative binomial model, a type of generalized linear model, in the state-level analysis, they adjusted for five potential confounders: poverty, urbanization, unemployment, alcohol consumption, and (nonhomicide) violent crime rates. In the multivariate analyses, a positive and significant association between gun ownership and homicide rates was found for

the entire population and for every age group (except age 0–4), primarily due to higher firearm homicide rates.

At the regional level, results demonstrated a positive and close to statistically significant association between firearm ownership rates and homicide. These regression models did not include additional independent variables because of the small number of census regions (nine). When the data were disaggregated by age, the positive association remained significant for persons over age 35. The association was largely due to the higher firearm homicide rates in regions with high firearm ownership. Results of the regressions were similar when either the GSS results or firearm suicides as a percentage of total suicides (FS/S) were used as the measure of gun availability.

In a subanalysis focusing on the states with the highest and lowest levels of gun ownership, the authors found that persons living in states with the highest gun ownership were much more likely to be victims of homicide compared to residents of low ownership states (RR = 2.9).

The same authors performed a similar study focusing only on children age 5–14 (Miller et al., 2002c). Using the same time period (1988–1997) and vital statistics data for suicide and homicide, the authors used multiple measures of gun availability including the GSS for regions, Cook's index, and the percent of suicides involving a firearm (FS/S), and for 21 states, the Behavioral Risk Factor Surveillance Survey (BRFSS), to assess the relationship between firearm availability and homicide involving children.

At the state level, using each measure of ownership, there was a statistically significant positive relationship between gun availability and homicide. At the regional level, there was a positive but not significant association between the GSS measure of availability and homicide.

When the authors compared the number of firearm deaths to children in the states with the highest and lowest levels of gun ownership as ranked by Cook's index, they found that children were much more likely to die from homicide in states with high levels of ownership compared to states with low levels (RR = 2.2).

The authors highlight the fact that these findings are robust to various measures of firearm availability and are not sensitive to the exclusion of the five highest or the five lowest states of ownership.

The third study in this series looked at the association between firearm availability and homicide victimization of women (Miller et al., 2002b). The methods and data were similar to the prior studies that utilized panel data from 1988 to 1997. The authors focused on deaths to women age 20 and older and controlled for state-level poverty and urbanization. The same four measures of gun availability, the GSS, BRFSS, Cook's index, and FS/S, were used in this study.

Bivariate and multivariate results demonstrated a positive and statistically significant relationship between gun availability and homicide to women at the state level using all three measures of firearm availability. This relationship was accounted for primarily by firearm homicide rates. The significant association remained at the regional level. When the five high gun states were compared to low gun ownership states, women were 2.7 times more likely to die from homicide in the high ownership states.

The authors point out that while certain factors related to levels of violence were controlled for in the regression analyses at the state level, at the regional level, no additional covariates were included. None of the Miller et al. (2002a, 2002b, 2002c) studies account for the possibility of reverse causation.

3.4. Summary of U.S. ecological studies

As with all ecological studies, aggregation at large levels of measurement limit conclusions about causality. It remains difficult to control for all possible factors related to homicide rates, and in time series analyses, the temporal sequence of homicide and gun ownership is difficult to determine.

The time series results are probably most compelling at the local level (e.g., Detroit, California) but are not necessarily generalizable. Time series results at the national level are somewhat less convincing. Both gun prevalence and gun homicides may be increasing over some time period, but gun prevalence may be largely increasing in some locales while gun homicide may be increasing largely in others; national studies do not always provide disaggregate results. Many factors related to crime are changing over time in the United States at different rates and in different localities, and the causal effects of interventions often appear with an uncertain lag making it difficult to accurately model these possible confounders.

The evidence from the U.S. cross-sectional studies is quite consistent; across U.S. regions, states, and cities, where there are higher levels of gun prevalence, homicide rates are substantially higher, primarily due to higher firearm homicide rates. The state evidence is particularly compelling: even after accounting for poverty, unemployment, alcohol consumption, urbanization and crime levels, for both genders, and for virtually every age category, states with more guns (and typically more permissive gun laws) experience significantly higher homicide rates. The plausible causal path is clear—where there are more guns, children, adolescents, young adults, the middle aged, and the elderly men and women are more likely to be murdered with these guns.

The prime alternative explanation for the association of gun prevalence and homicide is that of reverse causation—where homicide rates are higher, families have obtained guns for protection. This hypothesis appears less reasonable for populations killed most often by family or intimates (e.g., children, women). Cross-sectional studies suggest that higher homicide rates may lead to higher levels of gun ownership (as well as vice versa), but it is difficult to accurately determine the importance of each effect.

It is also possible that some omitted variables might explain the association between gun prevalence and homicide. For example, a "culture of honor" may make the South more lethally violent (Corzine, Huff-Corzine, & Whitt, 1999), somewhat independent of the prevalence of firearms. But even eliminating the Southern states in the confederacy, in states with more guns there is more homicide. While we know of no evidence that shows that individuals in cities, states, or regions with more guns are more pathological, criminal, or violence prone, omitted variables should be considered a possible explanation for the association.

Cross-sectional studies generally find a large and statistically strong association between firearm prevalence and firearm homicide. In addition, the studies sometimes find a weaker, but important and significant, relationship between firearm prevalence and nonfirearm homicide. This latter finding might indicate omitted variable bias. For example, it may be that areas with more guns have cultures that are more lethally violent even without guns, and the control variables in the analysis do not sufficiently account for this. However, it is also possible that more guns causally increase nongun homicide. Four reasons might be labeled: (a) retaliation, (b) criminal justice congestion, (c) reduction in social capital, and (d) changes in societal norms.

First, if more guns lead to more serious violence, the victims' family, friends, or gang associates may be more likely to seriously retaliate, killing the perpetrator and his friends or gang associates with a gun or by some other means. Second, if more guns lead to more serious crime, the police and court system may become overtaxed, reducing the probability of apprehending and convicting the correct perpetrator. This reduces the costs of crime to the perpetrator, which can increase the amount and seriousness of criminal behavior. Third, when serious crime increases, community trust and interaction fall. Regular citizens become afraid to go out at night, making the streets even less safe. Fear may lead to neighborhood instability as longtime inhabitants decide to move out. The reduction in the social fabric of the community may increase the likelihood of serious crime and homicide by all methods. Evidence shows that in the United States, states with more guns have lower levels of trust and social interaction (Hemenway, Kennedy, Kawachi, & Putnam, 2001). Finally, an increase in gun homicide may increase the social tolerance for lethal violence of all kinds, reducing community responses to high homicide rates.

The fact that areas with more guns have higher nongun homicides may also be due to reverse causation—higher homicides, by any method, leads to more households obtaining guns for protection. The theory that claims that if guns became less available, determined killers would simply substitute other methods for firearms implies a negative rather than a positive relationship between gun prevalence and nongun homicide and is inconsistent with the positive association observed.

4. Conclusion

The available evidence is quite consistent. The few case control studies suggest that households with firearms are at higher risk for homicide, particularly firearm homicide. International cross-sectional studies of high-income countries find that in countries with more firearms, both men and women are at higher risk for homicide, particularly firearm homicide. This result is primarily due to the United States, which has the highest levels of household ownership of private firearms, the weakest gun control laws, and the highest homicide rates. Time series studies of particular cities and states, and for the United States as a whole, suggest a positive gun prevalence-homicide association. Finally, perhaps the strongest evidence comes from cross-sectional analyses of U.S. regions and states. Again, places with higher levels of gun ownership are places with higher homicide rates.

None of the studies can prove causation and none have completely eliminated the possibility that the association might be entirely due to reverse causation or omitted variables. But the available evidence is entirely inconsistent with the hypothesis that increased gun prevalence lowers the homicide rate. Instead, most studies, cross sectional or time series, international or domestic, are consistent with the hypothesis that higher levels of gun prevalence substantially increase the homicide rate.

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