Can Owning a Gun Really Triple the Owner's Chances of Being Murdered?

The Anatomy of an Implausible Causal Mechanism

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Using a case-control design comparing homicide victims with matched nonvictims, Kellermann et al. (1993) concluded that keeping a gun in one's home increased the risk of being murdered by a factor of 2.7. The authors' underlying assumption was that a significant elevation in homicide risk derived from the risk of being murdered with a gun kept in the victim's home. This article shows that homicides are rarely committed with guns belonging to members of the victim's home and that such killings could be responsible for no more than a 2.4% increase in the relative risk of being murdered. Guns in one's own home have little to do with homicide risk. Scholars need to attend more closely to the mechanisms by which an alleged causal effect is supposed to operate and to consider their plausibility before concluding that an association reflects a causal effect.

Criminologists have long been interested in the impact of gun availability on homicide. Traditionally, the central hypothesis guiding research was that if Person X attacked and injured Person Y, Person X's possession and use of a gun would increase the probability that the injury inflicted was fatal (Kleck, 1997; Wright, Rossi, & Daly, 1983; Zimring, 1968). Thus, Person X's possession of a gun increases Person Y's risk of becoming a homicide victim. Recently, researchers publishing in medical journals and following a public health model of violence have radically altered this paradigm, asserting that Person X's possession of a firearm increases the likelihood of Person X becoming a homicide victim (Kellermann

et al., 1993; see also Cummings, Koepsell, Grossman, Savarino, & Thompson, 1997).

This change in emphasis was accomplished partly by shifting the focus from individual gun possession to household possession. That is, it has been hypothesized that persons who live in a household containing guns, regardless of which individual residents own them, are at greater risk of homicide victimization (Kellermann et al., 1993). The mechanism by which this causal effect is supposed to operate has not been explicitly described, but the most obvious candidate (perhaps so obvious that public health scholars thought it did not require explicit statement) would be that one resident of a gun-owning household would use a household gun to kill another resident of the household.

The shift in focus from homicide offending to homicide victimization under this paradigm may, however, be more apparent than real, because if household gun ownership increased the likelihood of one resident becoming a homicide victim, this would also necessarily imply that household gun ownership increased the likelihood of someone else committing a homicide.

THE KELLERMANN ET AL. (1993) HOMICIDE STUDY

In one of the most frequently cited academic articles published in recent years on the link between guns and homicide (as of September 15, 2000, it had been cited 177 times in journals covered by the Web of Science database), Arthur Kellermann et al. (1993) concluded that keeping a gun in one's household increased the odds of becoming a homicide victim by a factor of 2.7. This conclusion was based on a case-control study of homicide victims in three urban counties in the 1987 to 1992 period, in which the victims were compared with controls who were matched on sex, race, approximate age, and neighborhood of residence. After controlling for five other possible risk factors, the authors' logistic regression estimates indicated that persons with a gun in their households were 2.7 times more likely to become homicide victims than persons without a gun. The authors stated their conclusions in strong terms and were explicit as to what they regarded as the implications of their findings: "People should be strongly dis-

couraged from keeping guns in their homes" (p. 1090). This conclusion would not make sense unless the authors were asserting that keeping a gun in the home caused an increased risk of homicide victimization.

Critics pointed out an obvious alternative explanation of the results: Many of the same factors that place people at greater risk of becoming a victim of violence also motivate people to acquire guns, especially handguns, for self-defense. Thus, one would expect a positive association between gun ownership, especially handgun ownership, and homicide victimization even if the former had no effect on the latter (Kates, Schaffer, Lattimer, Murray, & Cassem, 1995, pp. 588-589; Kleck & Hogan, 1999).

In short, the association discovered by Kellermann et al. (1993) looked like a spurious association attributable to confounding factors not controlled by the analysts, such as membership in a street gang or involvement in illicit drug dealing (as distinct from mere drug use). Although these two risk factors are common only among adolescents and young adults, they nevertheless could easily generate a large spurious association between homicide victimization and gun ownership, because 52.1% of the victims in the Kellermann et al. study were ages 15 to 39 (reanalysis of Kellermann, Hackman, Rivara, Rushforth, & the University of Tennessee, 1997).

A number of other flaws in this research have been identified, including the use of local samples that were not representative of any larger populations as well as errors in measurement of gun ownership that were sufficiently common to completely account for the observed association (Kleck, 1997, pp. 243-246; Kleck & Hogan, 1999). This article, however, focuses on the plausibility of the mechanism by which household gun ownership is presumed to elevate the risk of being murdered.

HOW IS THE GUN EFFECT
SUPPOSED TO WORK?

It is common in epidemiological research for analysts asserting a causal effect of a risk factor on a disease or other outcome to describe some mechanism by which the causal effect could operate. A researcher might hypothesize, for example, that exposure to

swamplands could increase the risk of contracting malaria because swamp-bred mosquitos can bite a person carrying the disease and then infect a previously healthy person by biting him or her as well, transmitting infected blood from the first person.

Kellermann et al. (1993), however, did not say why or how gun ownership by a given person or members of the person's household would increase that person's risk of being murdered. The closest the authors came to saying anything at all on this matter was a single sentence citing a previous study that found that assaults with a gun are more likely to result in death than are assaults with other weapons (p. 1090). Many readers may not have noticed the omission of this element of the epidemiological argument, perhaps for the same reason the authors may not have provided it: The nature of the causal mechanism may have been regarded as too self-evident to need describing. The obvious, most direct, and perhaps the only plausible mechanism would be that attackers, especially those living in the same home as the victim, would use a gun kept in the victim's household to kill the victim. Note that it is unnecessary for what follows for any assumption to be made concerning the nature of this mechanism, other than that the higher homicide risk is somehow due to the risk of being killed with a gun kept in the prospective victim's home.

Thus, the plausibility of the authors' interpretation of their findings depends heavily on what fraction of homicides are committed with a gun kept in the victim's home (referred to hereafter as a "victim gun"). The authors, however, were silent on this matter, and some readers of their article noticed the omission. Soon after the article's publication, the *New England Journal of Medicine* published a series of letters commenting on the article, including one from a group of students in a college statistics class (The Students of Dr. Mark Ferris's Mathematical Statistics 460, 1994). The students pointed out that although Kellermann et al. (1993) were arguing that guns in the household raised one's risk of being murdered, the authors had not stated how many homicide victims in their sample had been killed with a victim gun rather than a gun that was brought to the scene by the perpetrator. Many others also noted this omission (e.g., Kates et al., 1995, pp. 586-587; Kleck, 1997, p. 245, 1998; Kleck & Hogan, 1999; Lott, 1998, p. 24).

The omission seemed very odd indeed, both because the information was crucial to establishing the plausibility of the analysts'

conclusions and because the researchers had gathered information from police offense reports on the homicides, precisely the source that would indicate where the murder weapon had come from. In their reply to the students' letter, Kellermann, Somes, and Rivara (1994) did allude to eight cases where "the gun involved had been kept in the home" (p. 368) but did not say whether these eight cases constituted all of the victim-gun cases or make it clear whether all of these eight guns had been kept in the victim's home rather than the offender's home. Indeed, they did not even state whether they had consistently tried to record the origins of homicide guns.

Nevertheless, even without this crucial datum, Kleck (1998) pointed out that less than 5% of the homicides in the area studied by these authors were likely to have involved guns kept in the victim's household, because reanalysis of Kellermann et al.'s (1993) data indicated that only about 88 of the 1,860 total homicides in the study area (a) occurred in or near the victim's home, (b) were committed with a gun, and (c) were committed by a killer whose relationship with the victim indicated that he or she was likely to live in the same household as the victim. Even when victims were killed in their own homes, most were killed by a person who, based on his or her relationship to the victim, probably lived elsewhere and thus presumably used a gun brought from elsewhere.

HOW OFTEN ARE PEOPLE MURDERED WITH GUNS FROM THEIR OWN HOMES?

The inference that few of the victims in the Kellermann et al. (1993) sample were killed with guns kept in their own homes necessarily relied on the assumptions that (a) one could reliably tell whether the killer lived with the victim from their relationship and that (b) few killers from outside the victims' homes would use a victim gun to commit the killing. It would be better to have direct information on the number of home homicides committed with victim guns. Unfortunately, the version of the Kellermann et al. (1993) data set that was released to the Inter-university Consortium for Political and Social Research (ICPSR) data archive did not contain any information on where homicide guns came from (see Kellermann et al., 1997). In a registered letter sent to Kellermann,

the author asked Kellermann whether his team had gathered data on the origins of homicide guns in his case-control study and, if so, what share of homicide guns were victim guns. Kellermann did not reply.

Recently, however, Kellermann, Somes, Rivara, Lee, and Banton (1998) published a study based on a closely related data set, and these data provide a close approximation of the victim-gun share. They reported findings from a study of fatal and non-fatal gunshot wounds in Seattle, Washington; Memphis, Tennessee; and Galveston, Texas, from 1992 to 1994. Thus, the time span examined in the 1998 study immediately followed and even partially overlapped the 1987-1992 span covered in their homicide case-control study. Furthermore, two of the three cities studied in the 1998 study, Seattle and Memphis, and their surrounding counties had supplied about 70% of the homicides studied in the 1993 homicide case-control study (computed from homicide counts for the cities, in Federal Bureau of Investigation, 1988-1993) and 95% of the gunshot cases in the 1998 study (computed from data in another report based on the data in the 1998 study; see Kellermann et al., 1996, p. 1439). Patterns of gun violence in the homicide case-control study should therefore closely resemble patterns in the 1998 study.

The Kellermann et al. (1998) article reported analyses of 438 criminal assaults and homicides committed with a gun in or near a residence. The authors found that 49 of these incidents involved a gun "kept in the home where the shooting occurred" (p. 264), 295 involved a gun brought to the scene from elsewhere, and another 94 involved a gun whose origins were not noted by the police. Thus, among the 344 (49 + 295 = 344) residential shootings involving a gun with known origins, only 14.2% (49/344 = .142) involved a gun kept in the home where the shooting occurred.

Furthermore, many of these shootings almost certainly occurred in the home of the attacker and not of the victim and thus were more likely to have involved a gun belonging to the offender than to the victim or another member of the victim's household. For example, in Wolfgang's (1958, p. 123) classic study, 32% of home homicides occurred in the home of the offender only (i.e., not the victim's home) or the home of some third party. Thus, as few as 9.7% (14.2% × [1 − 0.32] = .097) of the in-home shootings were likely to have been committed with a victim gun. Never-

TABLE 1
Estimated Frequency of Homicides Committed
With the Victim's Gun (three urban counties, 1987-1992)

	Number	Percentage of Homicides
Total homicides	1,860	100.0
Homicides in victim's home	444	23.7
Gun homicides in victim's home	221[a]	11.9
Gun homicides in victim's home, with gun kept in victim's home	31[b]	1.7

SOURCE: Kellermann et al. (1993, pp. 1085-1086); Kellermann, Somes, Rivara, Lee, and Banton (1998, p. 254).
a. This is 49.8% of 444; Kellermann et al. (1993, p. 1086) reported that 49.8% of home homicides in their sample died from gunshot wounds.
b. Approximately 31. Assumes that 14.2% of gun homicides committed in the victim's home were committed with a gun kept in the victim's home, the same as was true in a sample of in-home fatal and nonfatal gunshot wounds in an overlapping set of areas from 1992 to 1994.

theless, we will generously use the 14.2% figure as an upper limit estimate of the victim-gun share of home homicides.

In their article, Kellermann et al. (1993, pp. 1085-1086) reported that 1,860 total homicides were committed in the study area, 444 of which took place in or near the home of the victim, and that 49.8% of these 444 were committed with a gun, implying a total of 221 gun homicides committed in or near the victim's home. Applying the upper limit 14.2% victim-gun share figure to the homicides in the 1993 study, 31 (14.2% of 221), at most, involved a victim gun (see Table 1). These 31 cases would constitute just 1.67% of the 1,860 homicides committed in the study area of the 1993 study. This is an upper-limit estimate of the share of homicides involving a gun kept in the victim's home, assuming that no victims were killed with a gun from the victim's household but in a place other than in or near the victim's home.

The explanation for the extreme rarity of victim-gun homicides is simple. Even in samples confined to gun incidents occurring in or near the victim's home, few of the shooters lived in the victim's home. Only 12.6% of the shooters ($n = 79$) in criminal assaults and homicides in the 1998 study were a spouse, family member, or "intimate" of the victim (Kellermann et al., 1998, p. 254), and not all of these necessarily lived with the victim. The vast majority of

the shooters came from outside the home, so it is not surprising that most of them used guns brought from a location outside the victim's home.

Given the rarity of victim-gun homicides, how could keeping a gun in one's home increase the risk of homicide by a factor of 2.7? Is it even mathematically possible that victim-gun ownership could increase homicide victimization—via any mechanism involving use of a victim gun—by anything even remotely approaching 170% if less than 2% of homicides are committed with a victim gun? A simple numerical example using national data can illuminate this issue.

THE IMPLICATIONS OF THE RARITY OF VICTIM-GUN HOMICIDE

The latest year covered in the Kellermann et al. (1993) case-control data set was 1992. In that year, there were 23,760 murders and nonnegligent manslaughters committed in the United States, in a population of 255,082,000, for an overall homicide victimization rate of 9.31 per 100,000 persons (Federal Bureau of Investigation, 1993, p. 59). A CBS/*New York Times* poll conducted in January 1992 indicated that 49% of U.S. households reported owning at least one gun (Kleck, 1997, p. 99). Assuming that households with guns and those without guns have the same average number of members, 124,989,200 (0.49 × 255,082,000) Americans lived in households with guns, and 130,090,800 lived in households without.

To give the guns-increase-homicide thesis its strongest form, assume that gun ownership is the only risk factor explaining differences in homicide risk. If the odds ratio of 2.7 were to be valid as a measure of actual causal impact of gun ownership prevailing in the national population, the annual homicide victimization rate would have to be 13.72 per 100,000 for persons living in households with guns (17,149 homicides among 124,989,200 people) and 5.08 per 100,000 for those in households without guns (6,611 homicides among 130,090,800 people). These are the only rates that can average out to the population-wide rate of 9.31 where the ratio of the gun household homicide rate over the no-gun household rate is 2.7.

Based on the data from the two Kellermann et al. (1993, 1998) studies, at most 1.67% of all homicides were committed with a victim gun. Applying this figure to the nation's 23,760 homicides yields an upper limit estimate that 396 killings were committed with a victim gun. These 396 homicides are by definition a subset of the estimated 17,149 homicides involving victims who live in households with guns, leaving 16,753 homicides of victims from gun-owning households who were not killed with guns kept in their own household. Thus, the estimated 396 killings committed with a victim gun would represent, at most, a 2.4% increase (17,149 / [17,149 − 396] = 1.024) over the number of killings of victims from gun-owning households that did not involve such a gun. Alternatively, the 396 victim-gun killings would represent an increment of just 1.7% over the total number of homicides in all households, regardless of gun ownership status (23,760 / [23,760 − 396] = 1.017).

Let us make two generous assumptions: (a) Every killing committed with a victim gun would not have occurred in the absence of that gun (i.e., none would have been committed either without a gun or with a gun from outside the victim's home); and (b) defensive gun use and gun ownership by potential homicide victims never deters or disrupts attacks that otherwise would have been fatal, and thus, there are no homicide-reducing effects of gun ownership by prospective victims to counterbalance homicide-increasing effects. Even under these extreme assumptions, the number of people living in households with guns who were murdered could be increased as a result of the use of victim household guns by a factor of no more than 1.024, whereas the number murdered in all U.S. households could be increased by a factor of no more than 1.017. Even the larger 1.024 ratio is only 1.4% as large an effect as that implied by the Kellermann et al. (1993) odds ratio of 2.70 ([1.023 − 1] / [2.7 − 1] = .014). Thus, the idea of a 2.7-fold increase in homicide risk due to use of guns kept in victims' homes is implausible even under the most favorable (and unrealistic) assumptions.

Recall, however, that Kellermann et al.'s (1993) conclusions actually applied only to homicides that occur in or near the victim's home. Homicides involving victim guns would be a larger share of home homicides than they would be of all homicides. If the distribution of U.S. homicides by location were the same as in

TABLE 2
Implications for Impact of a Gun in the Home on Homicide

Panel A

Homicide risks implied by the Kellermann et al. (1993) analysis if guns were the only risk factor for homicide in United States in 1992

	Population (in millions)	Number of Homicides	Homicides per 100,000
All homicides			
Persons in gun-owning households	125.0	17,149	13.72
Persons in nongun households	130.1	6,611	5.08
Total homicides	255.1	23,760	9.31
Ratio, homicide rates, gun-owning over nongun: 2.70			
Home homicides only			
Home homicides in gun-owning households		4,094	3.28
Home homicides in nongun households		1,578	1.21
Total home homicides		5,672	2.22

Panel B

Number of homicides under the assumption that all victim-gun homicides would not have occurred had there been no gun in the victim's home

	All Homicides	Home Homicides
Gun-owning households		
Involving victim gun	396	396
Not involving victim gun	16,753	3,698
Total	17,149	4,094
All households		
Involving victim gun	396	396
Not involving victim gun	23,364	5,276
Total	23,760	5,672
Relative increase in total homicides attributable to victim-gun homicides		
in gun-owning households	1.024 (17,149/16,753)	1.107 (4,094/3,698)
In all U.S. households	1.017 (23,760/23,364)	1.075 (5,672/5,276)

the Kellermann et al. study area (i.e., 23.9% in the home), this would imply there were 5,672 U.S. homicides occurring in or near the victim's home in 1992, for a rate of 2.22 home homicides per 100,000. Applying the same computational procedures as before, the rates of home homicides would, for the 2.7 ratio to prevail, have to be 3.2755 per 100,000 (4,094 home homicides among

124,989,200 persons) among persons living in households with guns and 1.2130 (1,578 home homicides among 130,090,800 persons) among those living in households without guns.

If we assume that all of the 396 victim-gun killings occurred in the victim's home, this would leave 3,698 homicides of victims living in a gun-owning household who were not killed with a victim gun (see Table 2, Panel B). Therefore, even if one made the extreme assumptions that all victim-gun homicides were uniquely attributable to the presence of a gun in the household and that gun ownership never resulted in deterring an attack or disrupting a homicidal attempt, the 396 victim-gun homicides would still represent, at most, a 10.7% increase in homicides among persons living in gun-owning households. This is only 6% of the effect claimed by Kellermann et al. (1993) ([1.107 – 1] / [2.7 – 1] = .06).

CONCLUSIONS

This analysis establishes that the most likely mechanism by which the effect posited by Kellermann et al. (1993) would operate is one that operates too rarely to have any substantial impact on the risk of being murdered. This effect is instead likely to be the product of a misinterpretation of an association that is mostly or entirely spurious.

This analysis does not, however, establish that there are no mechanisms by which some guns can increase homicide risks for some people. Kellermann and colleagues (1993) were merely mistaken in believing that gun ownership substantially increases the owner's risks of being murdered. A more reasonable approach to possible guns-homicide links would not focus exclusively on either the victim's home (where few gun homicides are committed, domestic homicides notwithstanding) or the victim's own guns. If some Americans are at greater risk of being murdered because of the availability of guns, it is primarily because of guns owned by people outside their household, fired at them in locations other than their own home.

Two more recent case-control studies of homicide both yielded findings indicating no effect of gun ownership on homicide victimization or homicide offending. Cummings et al. (1997) interpreted their findings as supporting the hypothesis that gun

ownership increases homicide risks, but their findings in fact strongly supported the view that the observed guns-homicide association was entirely spurious. If gun ownership really has the hypothesized effect on homicide risk, it must do so by increasing the risk of gun homicide in particular. On the other hand, if gun ownership in the study samples were merely a correlate of unmeasured risk factors that influence homicide in general—that is, both those homicides committed with guns and those not committed with guns—gun ownership would be no more strongly associated with gun homicide than with nongun homicide. The latter pattern is precisely what Cummings et al. found, supporting the view that gun ownership had no net causal effect on homicide risk but rather was correlated with uncontrolled factors that influenced both gun and nongun homicide victimization. These authors downplayed the significance of their findings, noting only that the association between gun ownership and homicide might be due to confounding, when in fact, the observed pattern of findings fitted perfectly with the hypothesis that the association was due to confounding.

Kleck and Hogan (1999) directly studied homicide offending, conducting a national case-control study that compared a nationally representative sample of imprisoned killers with the general adult population. The results of their logistic regression analysis, which was based on far larger and more representative samples and controlled for more potential confounders than was done in either the Kellermann et al. (1993) or the Cummings et al. (1997) studies, indicated that the likelihood of committing a homicide was only 1.36 times higher among those who owned a gun than among those who did not, which is an association that epidemiologists conventionally regard as "weak." Furthermore, the authors noted that because they, like previous researchers, did not control for known gun-associated risk factors such as street gang membership or drug dealing, even this weak association was at least partly spurious.

The larger lesson to be learned from this exercise is that scholars would benefit from attending more closely to the mechanisms by which supposed causal effects operate. The use of the vague term *risk factors*, common among public health scholars, encourages evasion of issues that a more straightforward confrontation of causation would force scholars to address. Had public health

researchers given more thought to the causal mechanisms that they apparently took for granted, they would have understood the crucial importance of information on how often (or how rarely) homicide victims are killed with guns from their own homes. And having acquired these crucial data, they would have more fully appreciated how implausible the causal effect they were assuming really was.

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