Homicide and Suicide Risks Associated With Firearms in the Home: A National Case-Control Study

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Study objective: I test the hypothesis that having a gun in the home is a risk factor for adults to be killed (homicide) or to commit suicide.

Methods: Two case-control analyses were based on national samples of subjects 18 years of age or older. Homicide and suicide case subjects were drawn from the 1993 National Mortality Followback Survey. Living control subjects were drawn from the 1994 National Health Interview Survey. Ten control subjects matched by sex, race, and age group were sought for each case subject.

Results: The homicide sample consisted of 1,720 case subjects and 8,084 control subjects. Compared with adults in homes with no guns, the adjusted odds ratio (OR) for homicide was 1.41 (95% confidence interval [CI] 1.20 to 1.65) for adults with a gun at home and was particularly high among women (adjusted OR 2.72; 95% CI 1.89 to 3.90) compared with men (adjusted OR 1.23; 95% CI 1.01 to 1.49) and among nonwhite subjects (adjusted OR 1.74; 95% CI 1.37 to 2.21) compared with white subjects (adjusted OR 1.27; 95% CI 1.03 to 1.56). Further analyses revealed that a gun in the home was a risk factor for homicide by firearm means (adjusted OR 1.72; 95% CI 1.40 to 2.12) but not by nonfirearm means (OR 0.83; 95% CI 0.62 to 1.11). The suicide sample consisted of 1,959 case subjects and 13,535 control subjects. The adjusted OR for suicide was 3.44 (95% CI 3.06 to 3.86) for persons with a gun at home. However, further analysis revealed that having a firearm in the home was a risk factor for suicide by firearm (adjusted OR 16.89; 95% CI 13.26 to 21.52) but was inversely associated with suicide by other means (adjusted OR 0.68; 95% CI 0.55 to 0.84).

Conclusion: Having a gun at home is a risk factor for adults to be shot fatally (gun homicide) or commit suicide with a firearm. Physicians should continue to discuss with patients the implications of keeping guns at home. Additional studies are warranted to address study limitations and to better understand the implications of firearm ownership.

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INTRODUCTION

Emergency department staff bear witness daily to the devastation caused by guns—more than 160 patients are treated for gunshot trauma in the United States each day[1]—and the American College of Emergency Physicians (ACEP) champions the potential to improve public health throughout the nation by focusing on firearms in particular.[2] If the potential is proportional to the exposure, it is great indeed: 1 in 3 US households contains firearms, and the number of guns in those homes approaches fully 200 million.[3]

By contrast, the number of case-control studies on gun-related mortality is commensurate with neither the death toll nor the firearms stock. Case-control designs have been used only twice to test whether access to guns makes Americans more likely to be shot and killed (homicide),[4,5] only once to test the converse (ie, whether owning a gun makes one more likely to kill another person),[6] only once to examine the likelihood of being shot and killed unintentionally,[7] and only 6 times to test whether access to guns poses a suicide risk.[5,8-12] Yet epidemiologists rely on the case-control design to make causal inferences,[13] especially for exposures not studied through randomized trials (guns are not assigned to some persons and kept from others). It is noteworthy that emergency physicians must rely on so little empiric evidence to explain the cause of a disease they treat daily.

Why are there so few attempts to quantify how gun availability and gun death relate? Perhaps we interpret the United States' experience as evidence enough that keeping guns at home increases the likelihood of being shot. Many homes contain guns,[3] almost half (43%) of all homicides and suicides occur in a home,[14] and most victims are shot (56% of the homicides and 61% of the suicides in 1998).[14] Furthermore, should we try to make the case that this association is causal, we can point to the few case-control studies that do exist,[4,5,7,8] bolster our position with evidence that areas with high gun ownership rates have the highest rates of gun-related mortality,[15-21] and make an argument that seems to satisfice.

On the other hand is the reality that most Americans who buy a handgun think it will protect their homes and families.[3] This practice is defended by citing evidence that persons frequently and effectively use guns to keep from being attacked and killed.[22]

The studies behind both conclusions have limitations: that guns confer protection[22] because the statistical method could have overestimated their benefit,[23,24] and that persons with guns in their home are at risk to be killed[4,5,7,8] because the results might be biased.[25] Whether gun ownership has a net benefit or risk remains debatable.[26-29]

An overlooked characteristic is that only one of the homicide and one of the suicide case-control studies (ie, those by Kellermann et al[4,8]) studied adults and classified individuals with the most direct measure of exposure used to date: whether their households contained guns. Despite this strength, both studies could have inaccurately estimated the effect of gun ownership because important confounding factors were not accounted for. Because of study limitations and suggesting that the deleterious effects of gun ownership are truly so large, these articles have, in the 10 years since their publication, inspired a paper trail of challenges that continues to grow.[25,30-36] We typically demand multiple tests of a hypothesis before judging the efficacy of a protective or risk factor.[37] No such literature has followed.

This study used case-control methods, national samples of adult homicide and suicide victims, and living matched control subjects and tested the hypothesis that having a gun in the home is a risk factor to be killed (homicide) or commit suicide.

MATERIALS AND METHODS

The case subjects and control subjects came from different data sources. Case subjects were drawn from the National Mortality Followback Survey (NMFS). The National Center for Health Statistics (NCHS) conducts the NMFS to collect information about persons who die in the United States. The NMFS conducted most recently (1993) was the first version to elicit firearm own-

ership information and to include decedents younger than 25 years.[38] The decedents (n=22,957) were sampled from the Current Mortality Sample, a systematic random sample of death certificates for US residents 15 years of age or older who died in 1993 (excluding decedents from South Dakota).[39]

Information about the decedents was gathered by interviewing their next of kin (65% by telephone and 35% in person). The response rate was 83%. The exposure of interest here, whether the decedent's household contained a gun, was based on the following question: "At any time during the last year of life, were there any firearms kept in or around [the decedent's] home? Include those kept in a garage, outdoor storage area, truck or car." Respondents were instructed to exclude firearms that could not fire, starter pistols, and BB (ie, nonpowder) guns.

Several of the interview questions yield information about the death: whether the homicide victim knew their killers, the nature of the homicide (eg, family argument), where the homicide or suicide incident occurred, and where death occurred. Locations of death include an ED, another hospital area, en route to a hospital, the victim's own home, and another person's home. Where the incident actually took place is unclear for victims who were at someone's home when injured (the category is "home or private area around the home," which does not distinguish the victim's home from someone else's). Responses to each question are presented below. The data do not indicate whether a fatal gunshot wound was inflicted with a gun that had been kept in the victim's home. This issue was informed by examining whether the victim had a gun in his or her home that matched the type of gun used fatally.

Living control subjects were drawn from the 1994 National Health Interview Survey (NHIS).[40] The NCHS conducts the NHIS annually to obtain detailed information about the health and health-related practices of noninstitutionalized civilians 17 years of age or older in the United States. For the first time, in 1994, an NHIS supplement elicited information about firearms in respondents' homes.[41] The supplement was administered during in-person interviews to one adult per family (n=19,738) in half the households in the 1994 NHIS sample. The response rate was 80%.

At the beginning of the firearms section, the interviewer had the option of reading this statement: "*Read if necessary:* Sometimes the use of firearms can lead to injury, which is a health problem" (italics in original). This statement was not included in the NMFS. Otherwise, the NHIS firearm questions were almost identical to those in the 1993 NMFS. Respondents were instructed to exclude guns that could not fire, starter pistols, and BB guns. They were then asked the following: "Are any firearms now kept in or around your home? Include those kept in a garage, outdoor storage area, truck or car."

Two case-control analyses were conducted, one for homicide and one for suicide. Death certificate information according to the *International Classification of Diseases*[42] was used to identify the homicide and suicide decedents in the data (ie, the case subjects). Control subjects were drawn randomly without replacement from the NHIS data and frequency matched to the case subjects by sex, race (white, black, and other), and age group (18 to 20, 21 to 24, 25 to 29, …, 90 to 94 years). To improve the precision of the parameter estimates, all available control subjects were used up to a ratio of 10 control subjects per case subject.[43] Case subjects 15 to 17 years old were excluded (20 suicide case subjects and 7 homicide case subjects) because no control subjects younger than 18 years of age were available for comparison. No perfectly matched control subjects were available for one suicide victim, a woman in the 85- to 89-year age group of race "other." This victim was matched with black control subjects of the same sex and age group. Subjects were considered exposed if they lived in a home where one or more firearms were reported present.

Conditional logistic regression was used to calculate adjusted odds ratios (ORs). These provide estimates of the net effect of having a gun in the home on being killed (homicide) or committing suicide.[44,45] The statistical models were estimated with Stata software (Stata Corporation, College Station, TX). Customary diagnostic procedures were used to assess and ensure

goodness of fit.[46] The 2 main analyses included all deaths, either by homicide or suicide. Then, separate models were estimated, including only subcategories of those variables to assess whether the effect of the exposure was consistent across categories of the matching variables (male and female; white and nonwhite; 18 to 24 years old, 25 to 39 years old, 40 to 64 years old, and 65 years or older). Homogeneity across these categories was tested with Wald statistics ($P<.10$).[47] Instances of effect modification are presented. The data were also analyzed by weapon type, with one analysis including only gunshot victims (and control subjects) and the other analysis including only persons killed by means other than a gunshot (and control subjects).

Variables for living arrangement (alone or not alone), marital status, education, annual family income, military veteran status, geographic region, and population of the locality where the subject lived were considered as potential confounders and included as covariates.[4,8,9,48] Covariates with nonstatistically significant coefficients (2-tailed, $P≥.05$) were excluded from a model if doing so resulted in a less than 5% change in the point estimate of the firearm variable.

Greater than 95% of the case subjects and control subjects had complete (no missing) data on the variables for living arrangement, marital status, education, and veteran status. The amount of missing data varied on the variables for the population (homicide control subjects 18.8%; suicide control subjects 24.6%), income (homicide case subjects 70.6%; suicide case subjects 64.6%; homicide and suicide control subjects approximately 13%), and firearm presence (homicide case subjects 36.6%; suicide case subjects 30.3%; homicide and suicide control subjects <3%). The analysis was conducted according to methods described by King et al[49] to account for the missing data. This involved creating a total of 5 data sets in which the missing values were replaced with multiply imputed values,[50] analyzing the 5 data sets simultaneously, and adjusting the SE estimates accordingly. The study was found exempt from full review by the University of California–Los Angeles Institutional Review Board.

RESULTS

The homicide analysis used 1,720 case subjects and 8,084 control subjects. Table 1 presents demographic characteristics. Overall, firearms were slightly more common in the homes of control subjects than case sub-

Table 1.
Characteristics of homicide case subjects 18 years old or older who died in 1993 and living control subjects.

Characteristics	Homicide	
	Case Subjects,[*] % (N=1,720)	Control Subjects,[†] % (N=8,084)
Demographic characteristics		
Sex		
Female	15.8	25.2
Male	84.2	74.8
Race		
White	43.0	70.5
Black	54.1	25.8
Other	2.9	3.7
Age, y (mean±SD)	33.1±13.5	38.4±14.6
Lived alone	19.7	24.3
Marital status		
Never married	57.2	30.2
Widowed, separated, divorced	16.8	19.4
Married	26.0	50.3
Education		
<High school	31.1	18.2
High school graduate	35.7	34.9
Some college	11.3	24.5
≥College graduate	22.0	22.4
Annual family income		
<$9,000	35.8	11.4
$9,000–$13,999	17.4	9.4
$14,000–$18,999	12.7	9.2
$19,000–$24,999	10.7	11.3
$25,000–$49,999	15.6	34.2
≥$50,000	7.9	21.5
Veteran	10.2	18.7
Region		
Northeast	14.7	19.7
Midwest	18.7	26.6
South	43.8	33.5
West	22.8	20.2
Population		
<250,000	12.9	9.9
≥250,000	87.1	90.1
Firearm(s) in home	30.7	34.0
Handgun(s)	20.1	18.6
Long gun(s)	18.5	29.1
Unspecified gun(s)	1.1	0.6

Valid percentages are shown.
[*]Data are obtained from the National Center for Health Statistics.[38]
[†]Data are obtained from the National Center for Health Statistics.[40]

jects. Long guns in particular were more common in control subjects' homes; the proportion of case subjects and control subjects with handguns in the home was very similar.

Most (56.7%) of the victims knew their killer. One fifth (20.1%) of the homicides occurred during a robbery, 15.5% during a family argument, 6.3% during a drug deal, and 1.1% during an abduction, and other unspecified motives accounted for 57.0% of the homicides. Table 2 presents other circumstances of the homicide incidents. Most of the victims died from gunshot trauma, which accounted for 77.9% of the male victims and 55.5% of the female victims. Most gunshots were from a handgun. More victims, almost one third of men and greater than one half of the women, were injured while in a home or area around a home than in any other location, and the proportion of incidents that occurred at a home increased with age. Additional data indicate that the respondent was likely referring to the victim's own home in a majority of the homicides. Among the

562 victims reported to have been in a home when the injury was sustained, more died in their own home than in any other location (ie, fully 47.2%), and only 10.9% died in another person's home. One quarter (25.1%) of the victims died in a hospital (17.4% died in an ED, and 7.7% died in another hospital area), and 4.5% died en route to a hospital.

Table 3 presents results from the logistic regression analysis. Compared with persons living in a home with no firearms, the adjusted OR for homicide was 1.41 (95% confidence interval [CI] 1.20 to 1.65) for persons living in a home where a gun was present. Subgroup analyses based on this regression model showed that the association between a gun in the home and homicide was present among younger and older persons, among white and nonwhite subjects, and among male and female subjects but was significantly higher among female subjects (adjusted OR 2.72; 95% CI 1.89 to 3.90) than among male subjects (adjusted OR 1.23; 95% CI 1.01 to 1.49) and was significantly higher among non-

Table 2.
Circumstances of homicide incidents by sex and age group.[*]

	Men,[†] %					Women,[†] %					Total (N=1,720)
Circumstances	18–24 y (N=475)	25–39 y (N=663)	40–64 y (N=283)	≥65 y (N=57)	Total (N=1,448)	18–24 y (N=60)	25–39 y (N=137)	40–64 y (N=60)	≥65 y (N=15)	Total (N=272)	
Homicide by gunshot	87.7	78.7	66.4	45.7	77.9	68.3	54.0	55.0	20.0	55.5	74.4
Specific means of homicide											
Handgun (E965.0)	51.8	40.8	36.0	26.3	42.9	30.0	27.0	31.7	20.0	28.3	40.6
Shotgun (E965.1)	3.4	7.3	7.4	12.3	6.2	8.3	3.7	5.0	0.0	4.8	6.0
Rifle (E965.2)	1.5	2.8	3.2	1.8	2.4	1.7	0.7	5.0	0.0	1.8	2.3
Other and unspecified gun (E965.4)	31.0	27.8	19.8	5.3	26.4	28.3	22.6	13.3	0.0	20.6	25.5
Strangulation (E963)	1.1	1.6	2.8	7.0	1.9	11.7	11.7	6.7	33.0	11.8	3.4
Cutting and piercing instrument (E966)	7.6	12.6	14.1	17.5	11.5	18.3	19.0	21.7	33.0	20.2	12.9
Blunt object (E968.2)	0.4	0.6	1.4	8.8	1.0	0.0	1.5	3.3	0.0	1.5	1.1
Other (nonfirearm)	2.7	3.5	9.5	14.0	4.8	0.0	7.3	6.7	0.0	5.2	4.9
Unspecified (E968.9)	0.6	3.0	5.7	7.0	2.9	1.7	6.6	6.7	13.3	5.9	3.4
Homicide location											
Home or private area around the home	23.8	26.2	36.4	61.4	28.8	41.7	49.6	73.3	80.0	54.8	32.9
Street or highway	30.5	24.6	17.3	3.5	24.3	10.0	11.7	8.3	0.0	9.9	22.0
Public building	2.7	3.6	3.5	1.8	3.3	1.7	0.7	0.0	0.0	0.7	2.9
Place of recreation or sport	1.7	2.8	0.7	1.8	2.0	1.7	1.5	0.0	0.0	1.1	1.9
Other	14.5	13.4	16.3	12.3	14.3	11.7	8.0	5.0	0.0	7.7	13.3
Not specified	26.7	29.2	25.8	19.3	27.3	33.3	28.5	13.3	20.0	25.7	27.1

[*]E-codes (external cause of death) are based on *International Classification of Diseases, Ninth Edition*.
[†]Data are obtained from the National Center for Health Statistics.[38]

white subjects (adjusted OR 1.74; 95% CI 1.37 to 2.21) than among white subjects (adjusted OR 1.27; 95% CI 1.03 to 1.56).

The link observed between a gun in the home and being killed was due entirely to an increased relative risk of homicide by gunshot. The adjusted OR for homicide by gunshot was 1.72 (95% CI 1.40 to 2.12), whereas the adjusted OR for homicide by means other than gunshot did not differ from the null value (adjusted OR 0.83; 95% CI 0.62 to 1.11).

The proportion of matches between the type of gun in the victim's home and the type of gun used fatally varied by the location where the shooting occurred. More than one third (33.8%) of the handgun victims who were shot in a home had a handgun in their home, whereas only 18.8% of the handgun victims who were shot in another location had a handgun in their home. The disparity was even greater for long guns: more than half (57.9%) of the shotgun victims who were shot in a

home had a shotgun in their home, whereas only 6.5% of the shotgun victims who were shot in another location had a shotgun in their home. A similar contrast was seen in persons killed with a rifle: more than one half (55.6%) of those shot at a home, compared with only one quarter (25.0%) of those shot in another location, had a rifle in their home.

The suicide analysis used 1,959 case subjects and 13,535 control subjects. Table 4 presents demographic characteristics. Firearms, handguns, and long guns were substantially more prevalent in the homes of suicide case subjects than control subjects.

Table 5 presents circumstances of the suicides. A gunshot injury was the most common type of self-directed injury, being used to commit suicide by 67.9% of the male victims and 41.7% of the female victims. The most commonly used type of firearm was a handgun. Most men and women were at a home when they committed suicide. Additional data indicate the respondent was likely referring to the victim's own home in a majority of the case subjects. Among the 1,107 suicide victims reported to have been at a home when the incident occurred, 74.0% of the victims died in their own home, and only 3.7% died in someone else's home. A small proportion (10.5%) of the victims died in a hospital, in an ED (4.9%), in another hospital area (5.6%), or en route (1.6%).

Table 6 presents results from the logistic regression analysis. Compared with persons living in a home with no firearms, the adjusted OR for suicide was 3.44 (95% CI 3.06 to 3.86) for persons living in a home where a gun was present. Subgroup analyses indicated that the association between having a gun in the home and using a gun to commit suicide was present among male and female subjects and among white and nonwhite subjects. This association was also present among persons of each age group but varied significantly across age groups. The net effect of having a gun in the home was highest among the youngest (age 18 to 24 years: adjusted OR 4.50; 95% CI 3.26 to 6.21) and oldest persons (age ≥65 years: adjusted OR 4.65; 95% CI 3.41 to 6.35) compared with others (age 25 to 39 years: adjusted OR 2.96, 95% CI 2.40 to 3.66; age 40 to 64 years: adjusted OR 3.20, 95% CI 2.54 to 4.04).

Table 3.

Adjusted ORs for homicide: Results of a case-control analysis of 1,720 matched sets.[*]

	Homicide	
Characteristics	**Adjusted OR**	**95% CI**
Living arrangement		
Alone (reference)	1.0	—
Not alone	2.37	1.96–2.87
Marital status		
Married (reference)	1.0	—
Never married	2.59	2.18–3.07
Widowed, separated, divorced	1.92	1.56–2.36
Did not graduate high school	1.35	1.16–1.58
Annual family income[†]	0.71	0.67–0.75
Veteran	0.65	0.53–0.80
Region		
Northeast (reference)	1.0	—
Midwest	0.80	0.65–0.99
South	1.32	1.09–1.59
West	1.65	1.35–2.03
Gun(s) in home		
No (reference)	1.0	—
Yes	1.41	1.20–1.65

[*]Adjusted ORs were calculated with conditional logistic regression, with control for covariates.
[†]Coded 1 (<$9,000), 2 ($9,000–$13,999), 3 ($14,000–$18,999), 4 ($19,000–$24,999), 5 ($25,000–$49,999), and 6 (≥$50,000).

Examining the data by suicide method revealed a striking contrast. Having a gun in the home was a strong risk factor for gun-related suicide (adjusted OR 16.89; 95% CI 13.26 to 21.52) but was inversely related to committing suicide with a nonfirearm method (adjusted OR 0.68; 95% CI 0.55 to 0.84). That is, persons

Table 4.
Characteristics of suicide case subjects 18 years old or older who died in 1993 and living control subjects.

Characteristics	Suicide	
	Case Subjects,* % (N=1,959)	Control Subjects,† % (N=13,535)
Demographic characteristics		
Sex		
Female	29.0	42.2
Male	71.0	57.8
Race		
White	87.0	89.9
Black	10.2	7.3
Other	2.8	2.8
Age, y (mean±SD)	48.0±20.7	45.8±18.2
Lived alone	27.3	26.5
Marital status		
Never married	29.3	20.7
Widowed, separated, divorced	27.8	23.7
Married	42.9	55.6
Education		
<High school	22.7	19.4
High school graduate	37.2	35.5
Some college	15.7	22.9
≥College graduate	24.4	22.3
Annual family income		
<$9,000	21.1	11.9
$9,000–$13,999	14.9	10.0
$14,000–$18,999	12.7	9.1
$19,000–$24,999	10.4	12.0
$25,000–$49,999	24.2	34.4
≥$50,000	16.7	22.8
Veteran	26.0	19.3
Region		
Northeast	14.9	20.5
Midwest	21.7	27.1
South	39.2	29.9
West	24.2	22.2
Population		
<250,000	26.4	11.3
≥250,000	73.6	88.7
Firearm(s) in home	65.8	36.7
Handgun(s)	53.0	19.7
Long gun(s)	53.8	31.7
Unspecified gun(s)	2.4	0.6

Valid percentages are shown.
*Data are obtained from the National Center for Health Statistics.[38]
†Data are obtained from the National Center for Health Statistics.[40]

with a gun in the home were more likely than others to use a gun to commit suicide and less likely than others to commit suicide by means of drug overdose, hanging, or other method other than a gun.

Persons who committed suicide in a home were more likely than others to have had a gun in their home that matched the type of the gun used fatally. However, in contrast to what was found among the homicide victims, the great majority of the suicide victims, regardless of where the suicide occurred, used a gun that matched a type of gun in their home. Fully 90.4% of the handgun victims who committed suicide in a home did have a handgun in their home, and fully 80.0% of the handgun victims who committed suicide in another location had a handgun in their home. Comparable results were seen among shotgun victims, among whom 93.0% of those shot at a home and 77.3% of those shot in another location had a shotgun in their home, and among victims shot with a rifle, among whom almost all (98.7%) of those shot at a home and fully 90.9% shot at another location had a rifle in their home.

DISCUSSION

A gun in the home is a risk factor for gun-related homicide and suicide among this sample of adults in the United States. A gun, when available, might be chosen over a less lethal method to commit suicide.[51] This might explain why the presence of a gun at home emerges as a risk factor for gun-related suicide and is inversely associated with suicide by means other than a gun. The increased risk for gun-related homicide might emerge because a gun can make an assault easier to attempt (because it requires no physical contact), and the case-fatality ratio is higher for firearm trauma than for injuries from weapons other than guns.[52,53]

The main contribution of the present findings might simply be their consistency with past results.[4,5,8] Nevertheless, it would be unwarranted to infer that such a limited body of research conclusively links gun availability to gun-related mortality.[37] Therefore, 2 of the replicate findings should be noted in particular, both to bolster conclusions made previously and to

guide prevention strategies. Among the adults studied here, the relative risk to be shot fatally (homicide) was significantly higher among women than men.[4] This likely reflects the singular danger faced by women in abusive relationships.[4,54] Second, a gun in the home was not related (not inversely related, specifically) to homicide by means other than a gun.[4,5] This runs contrary to the notion that keeping a gun at home makes household members less likely to be killed by intruders.[22] Not found previously, however, was that adults with guns at home were significantly less likely than others to commit suicide with a method other than a gunshot: the corresponding effect estimates found by Kellermann et al[4] and Cummings et al[5] were 0.7 and 0.8, respectively, but the CIs contained the null value. Perhaps the lethality of the weapon made persons who used a gun more likely to complete their suicide attempt, or they were more likely to attempt suicide because this method requires little preparation.

The homicide analysis presented here differed from the homicide study by Kellermann et al[4] by including victims regardless of where they were killed, as opposed to using only victims killed at home. Because location (home) and exposure (gun in the home) are related, restricting the sample by location might have created bias in the earlier study. The presence of a gun is likely related more strongly to homicide in, rather than away from, home. This might partially explain why the point estimates were larger in the earlier study.

It is important to consider competing explanations for the results. The association between having a gun at home and committing suicide with a gun could emerge because suicidal persons acquire a gun to take their own life. However, evidence from a previous study suggests that confounding by intent does not completely explain the effect estimates observed here.[24] Specifically, Cummings et al[5] found that persons who had a family member who bought a handgun were more likely than

Table 5.
Circumstances of suicide incidents by sex and age group.[*]

Circumstances	Men,[†] %					Women,[†] %					Total (N=1,959)
	18–24 y (N=223)	25–39 y (N=404)	40–64 y (N=360)	≥65 y (N=404)	Total (N=1,391)	18–24 y (N=57)	25–39 y (N=161)	40–64 y (N=228)	≥65 y (N=122)	Total (N=568)	
Suicide by gunshot	66.4	55.7	70.0	79.2	67.9	49.1	46.0	43.4	29.5	41.7	60.4
Specific means of suicide											
Handgun (E955.0)	30.0	27.5	40.0	41.3	35.2	29.8	29.8	29.0	21.3	28.4	33.0
Shotgun (E955.1)	9.9	9.7	13.6	14.4	12.1	3.5	4.4	4.0	0.8	2.9	9.6
Rifle (E955.2)	6.7	6.2	6.1	6.7	6.4	3.5	2.5	2.2	0.8	1.9	5.2
Other and unspecified gun (E955.4)	19.7	12.4	10.3	16.8	14.3	12.3	9.3	8.3	6.6	3.0	12.7
Hanging (E953.0)	16.6	20.3	9.4	6.7	12.9	8.8	15.5	6.1	8.2	8.6	11.9
Vehicle exhaust (E952.0)	2.2	7.7	4.7	3.7	4.9	5.3	6.8	8.8	5.7	5.6	5.6
Tranquilizers (E950.3)	2.2	1.7	1.4	0.0	1.2	8.8	6.8	10.5	2.5	6.4	3.1
Other (nonfirearm)	12.6	14.6	13.9	10.4	12.9	28.1	24.8	31.1	54.1	43.2	19.0
Unspecified (E958.9)	0.0	0.0	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Suicide location											
Home or private area around the home	49.3	47.5	53.1	69.8	69.9	56.1	55.3	60.5	59.8	62.8	56.5
Street or highway	5.4	3.7	3.9	1.2	4.1	8.8	2.5	3.1	2.5	3.7	3.3
Place of recreation or sport	1.8	2.7	3.3	0.5	1.1	5.3	2.5	2.2	0.8	0.7	2.1
Public building	1.8	1.0	1.1	0.3	2.7	1.8	1.2	0.4	0.0	2.6	0.9
Other	12.6	16.3	15.3	4.9	15.9	7.0	9.9	8.3	10.7	9.9	11.2
Not specified	29.2	28.7	23.3	23.3	6.2	21.1	28.6	25.4	26.2	20.3	25.9

[*]E-codes (external cause of death) are based on *International Classification of Diseases, Ninth Edition.*
[†]Data are obtained from the National Center for Health Statistics.[38]

others to kill themselves with a gun; the effect persisted for 5 years after the purchase.

Regarding competing explanations for the homicide findings, first, a gun in the home might indicate that a person lives or works in a high-crime neighborhood and purchased the gun for protection. The danger might stem from potential assailants in the neighborhood and not from the presence of the gun in the victim's home.[24] Second, many Americans carry firearms for purposes other than work (ie, an estimated 1.1 million persons on any given day).[3] Keeping a gun at home might only appear to pose a risk to be shot, whereas the danger might actually stem from drawing a gun when confronted by an assailant. An assailant might respond with greater force, which increases the likelihood that the assault will be fatal.[55] Third, the results could be biased because risky behaviors like drug dealing could not be controlled with the data used here.[6,25,29] How-

ever, confounding by neighborhood, by gun carrying, or by drug dealing is not likely to explain the results completely. If these were viable explanations, a gun in the home should be associated (as a proxy) with homicide by all means. In this study, having a gun at home was strongly associated with gun-related homicide, but it was not related to homicides not involving a gun. Earlier findings were similar.[4,5]

There are methodologic limitations. First, numerous factors affect the accuracy of survey-based firearm data.[56-58] The data used here might be similarly affected. For example, husbands and wives might not be equally familiar with the guns in their home and thus might answer differently.[57] Whether a given subject has valid gun data might therefore depend on who was interviewed. Because the case subjects and control subjects came from different sources, this study warrants considerations that build on this initial consideration. There are reasons to expect that the proportion of subjects classified correctly as exposed was not equal among case subjects and control subjects. One reason to expect fewer case subjects than control subjects to be classified correctly is that the gun data for case subjects came from next of kin; that is, from persons who might not have lived with the decedent and might have known little about their guns.[59] By contrast, fewer control subjects than case subjects could be classified correctly if control subjects were disinclined to admit owning guns on a survey in which this was eschewed. Bias from differential misclassification could have resulted for these and other reasons and in a direction that cannot be anticipated.[60]

Large proportions of responses were missing in the variable of interest: whether a firearm was in the home. The multiple imputation techniques used here are designed for such circumstances but do not obviate the limitations of incomplete data. Generalizability should also be addressed. The homicide findings of Kellermann et al[4] were vilified on grounds that, because the subjects did not represent the US population, they could not be generalized.[29] However, the worth of a study does not hinge on whether it used representative study groups. Strength comes instead from being able to

Table 6.

Adjusted ORs for suicide: Results of a case-control analysis of 1,959 matched sets.[*]

Characteristics	Suicide	
	Adjusted OR	**95% CI**
Living arrangement		
Alone (reference)	1.0	—
Not alone	1.83	1.55–2.16
Marital status		
Married (reference)	1.0	—
Never married	2.79	2.33–3.34
Widowed, separated, divorced	2.09	1.78–2.45
Annual family income[†]	0.80	0.77–0.84
Region		
Northeast (reference)	1.0	—
Midwest	0.90	0.76–1.07
South	1.31	1.12–1.53
West	1.34	1.13–1.58
Population		
<250,000 (reference)	1.0	—
≥250,000	0.65	0.57–0.73
Gun(s) in the home		
No (reference)	1.0	—
Yes	3.44	3.06–3.86

[*]Adjusted relative risks were calculated with conditional logistic regression, with control for covariates.
[†]Coded 1 (<$9,000), 2 ($9,000–$13,999), 3 ($14,000–$18,999), 4 ($19,000–$24,999), 5 ($25,000–$49,999), and 6 (≥$50,000).

make valid comparisons between case subjects and control subjects.[61] Toward this goal, sampling weights were not applied here. Had this been done, it would have been necessary to account for the primary sampling units and sampling strata to obtain accurate variance estimates and CIs. Doing so precludes analysis because the case subjects and control subjects came from separate sources and hence different primary sampling units and strata (yielding no cells with discordant pairs). The case-control study of homicide offending by Kleck and Hogan[6] also used separate case and control data sets. Although sampling weights were applied, there is no mentioned adjustment of the variance with respect to primary sampling units and sampling strata.

A limitation comes from not knowing whether the gun used fatally had actually been kept in the victim's home. This study found consistency between the type of gun in the home and the type used fatally but could not establish the gun's true origin. The Kellermann et al[4,8] studies have the same limitation.[6,29,62] A study of battered women in California does, however, link guns kept at home to intimate partner violence, a cause of some deaths in the present sample. Women who had been threatened or beaten with a firearm by their male partner reported frequently that he owned the gun and kept it at home.[63]

Ten potential confounders were controlled for in this analysis. However, the greatest source of potential bias might be confounding from risk factors that were not measured or were controlled only partially. For example, confounding by locality (ie, urban versus rural) might have been better controlled with specific demographic information. Locality is a potential confounder because it is related to both firearm availability and the likelihood that a sustained injury will be fatal because emergency medical response times vary. Other potential confounders that were not controlled were mental illness among subjects or family members[8,9] and histories of violence,[4] illicit drug[4,8] and alcohol use,[8] time spent (exposed) at home, and lifestyle factors like gang membership and drug dealing.[6,25,29]

Finally, the use of data from the early 1990s, the same period of the earlier studies of the homicide[4] and suicide[8] risks associated with keeping guns at home, was a coincidence. The data were used because they are rich sources collected for public health research but were not used in this way previously. A consequence of using dated data is that the risks associated with gun ownership that apparently existed in the early 1990s might be different today as a result of changes in attitudes toward gun ownership, gun ownership patterns, gun storage practices, and so on. Cummings et al,[5] who found that a family handgun purchase was a risk factor for gun-related homicide and suicide, conducted their study more recently (1997) but studied an even earlier time period (deaths that occurred between 1980 and 1992).[5] Studies in the current context are needed.

To address limitations and to better understand the implications of owning firearms and keeping them at home, it remains important to collect additional and more comprehensive data,[64] to control for confounders beyond those related to individuals (eg, neighborhood factors),[24,29] to more accurately measure firearms exposure, and then to evaluate whether the risks and benefits of gun ownership are consistent with the evidence to date. The attention might then shift to developing interventions and to the prevention efforts that ACEP encourages. Attributable fractions in the exposed population (OR–1/OR)[24,65] provide a sense of just how many deaths could be prevented by reducing exposure to firearms. If the effect of gun availability on gun-related mortality is truly of a magnitude similar to what was found here, the estimates suggest that 41% of the gun-related homicides (1.7–1/1.7=0.41) and fully 94% of the gun-related suicides (16.9–1/16.9=0.94) among persons with guns in their home would not have occurred under the same circumstances had no guns been present. The public health would benefit greatly if persons were less exposed to home-kept firearms.

Emergency physicians can play a preventive role, extending their ability to improve the public health beyond the critical care they provide patients presenting with gunshot trauma. Keeping guns at home appears dangerous for adults regardless of age, sex, or race, but those at particularly high risk to be shot likely include persons contemplating suicide and women in abusive

relationships. When patients appear suicidal or to have suffered domestic violence, the questions physicians ask should include questions about guns. Are there any guns in your home? Do you or your family members own any guns? Physicians can then discuss the implications and discuss options to make living environments safer. For female patients especially, Coyne-Beasley and Johnson[66] recommend talking about the degree to which their partners will discuss firearm issues and tailoring counseling strategies accordingly. Because persons who do not own guns likely know someone who does, the consequences of having access to guns are important to discuss with all patients.

In summary, on the basis of national samples drawn in the early 1990s, adults who have a gun or guns in their home appear at risk to be shot fatally (gun homicide) or to take their own life with a firearm. Physicians should continue to discuss these implications with patients who own guns or have guns at home and to consider how patients might make their environment safer.

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