Annals of Internal Medicine | Review

The Accessibility of Firearms and Risk for Suicide and Homicide Victimization Among Household Members

A Systematic Review and Meta-analysis

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Background: Research suggests that access to firearms in the home increases the risk for violent death.

Purpose: To understand current estimates of the association between firearm availability and suicide or homicide.

Data Sources: PubMed, EMBASE, the Cochrane Central Register of Controlled Trials, and Web of Science were searched without limitations and a gray-literature search was performed on 23 August 2013.

Study Selection: All study types that assessed firearm access and outcomes between participants with and without firearm access. There were no restrictions on age, sex, or country.

Data Extraction: Two authors independently extracted data into a standardized, prepiloted data extraction form.

Data Synthesis: Odds ratios (ORs) and 95% CIs were calculated, although published adjusted estimates were preferentially used. Summary effects were estimated using random- and fixed-effects models. Potential methodological reasons for differences in effects through subgroup analyses were explored. Data were pooled from 15 observational studies that assessed the odds of suicide or homicide, yielding pooled ORs of 3.24 (95% CI, 2.41 to 4.40) and 1.94 (CI, 1.44 to 2.93), respectively. When only studies that used interviews to determine firearm accessibility were considered, the pooled OR for suicide was 3.14 (CI, 2.29 to 4.43).

Limitations: Firearm accessibility was determined by survey interviews in most studies; misclassification of accessibility may have occurred. Heterogeneous populations of varying risks were synthesized to estimate pooled odds of death.

Conclusion: Access to firearms is associated with risk for completed suicide and being the victim of homicide.

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Firearms cause an estimated 31 000 deaths annually in the United States (1). Data from the 16-state National Violent Death Reporting System indicate that 51.8% of deaths from suicide in 2009 ($n = 9949$) were firearm-related; among homicide victims ($n = 4057$), 66.5% were firearm-related. Most suicides (76.4%) occurred in the victims' homes. Homicides also frequently occurred in the home, with 45.5% of male victims and 74.0% of female victims killed at home (2).

Firearm ownership is more prevalent in the United States than in any other country; approximately 35% to 39% of households have firearms (3, 4), and 22% of persons report owning firearms. The annual rate of suicide by firearms (6.3 suicides per 100 000 residents) is higher in the United States than in any other country with reported data, and the annual rate of firearm-related homicide in the United States (7.1 homicides per 100 000 residents) is the highest among high-income countries (4). Results from ecological studies suggest that state restrictions on firearm ownership are associated with decreases in firearm-related suicides and homicides (5).

Specific characteristics about storage and types of firearms seem to increase suicide risk. Firearms that are stored loaded or unlocked are more likely to be used than those that are unloaded or locked (6, 7), and adolescent suicide victims often use an unlocked firearm in the home (8). The apparent increased risk for suicide associated with firearms in the home is not unique to persons with a history of mental illness (7) and may be more of an indicator of the ease of impulsive suicide.

Impulsiveness may be a catalyst in using a firearm to commit suicide and may also play a role in firearm-related homicide. Researchers have estimated higher odds of homicide victimization among women than men (9, 10). Because most homicide victims know their perpetrators (9), this finding may indicate an impulsive reaction to domestic disputes.

To our knowledge, this is the first systematic review and meta-analysis to estimate the association between firearm accessibility and suicide or homicide victimization.

Methods

We used Cochrane Collaboration methods (11) throughout the review process.

Data Sources and Searches

We searched PubMed, EMBASE, the Cochrane Central Register of Controlled Trials, and Web of Science without date, geographic, or language limitations. We also examined bibliographies of included articles to identify ad-

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Table 1. **Summary of Critical Appraisal of Included Studies Using the Newcastle–Ottawa Scale for Assessing the Quality of Observational Studies***

Study, Year (Reference)	Stars, *n*		
	Selection†	Comparability‡	Exposure§
Suicide outcomes			
Brent et al, 1988 (16)	3	1	1
Brent et al, 1991 (17)	3	2	1
Kellermann et al, 1992 (7)	4	2	1
Brent et al, 1993 (6)	4	2	2
Beautrais et al, 1996 (20)	4	2	2
Cummings et al, 1997 (22)	3	1	3
Shah et al, 2000 (8)	4	2	1
Conwell et al, 2002 (21)	4	2	1
Grassel et al, 2003 (24)	4	1	3
Kung et al, 2003 (18)	4	2	1
Wiebe, 2003 (10)	4	1	1
Mahon et al, 2005 (25)	4	1	3
Kung et al, 2005 (19)	4	2	1
Homicide victimization outcomes			
Kellermann et al, 1993 (9)	4	2	2
Cummings et al, 1997 (22)	3	1	3
Grassel et al, 2003 (24)	4	1	3
Wiebe, 2003 (10)	4	1	1

* Reference 23 not shown because the scale is different for cohort studies.
† Maximum 4 stars.
‡ Maximum 2 stars.
§ Maximum 3 stars.

ditional references. In addition, we searched the gray literature for papers related to firearms and suicide or homicide. The **Appendix** and **Appendix Table 1** (both available at www.annals.org) present details of our search strategy and screening process.

Study Selection

Study Design

Study designs eligible for inclusion in our review were randomized, controlled trials; nonrandomized, controlled trials; pre- or postintervention evaluations; and observational studies (for example, cohort or case–control studies) if a comparator was available. Because we were concerned with the individual effects of firearm accessibility, we included only studies with individual-level data and excluded those with population-level data (for example, ecological studies).

Types of Participants

Participants were not restricted by age, sex, or country of residence.

Types of Exposures

Studies needed to assess whether firearms were available for all participants. In addition, included studies needed to assess outcomes between participants with and without access to firearms. Specifically, studies needed to compare firearm ownership or availability (that is, accessibility) with no firearm ownership or availability (that is, no accessibility) or provide adequate data to estimate the effect that firearms had on selected harms outcomes. Firearm accessibility could be defined as self- or proxy-reported or assumed from other types of exposure data (for example, firearm purchase records).

Types of Outcome Measures

The primary outcomes of interest were suicide or homicide victimization (that is, being a victim of homicide rather than a perpetrator).

Data Extraction and Quality Assessment

Two authors independently extracted relevant data into a standardized, prepiloted data extraction form.

Assessment of Risk of Bias

Two authors independently assessed the risk of bias for each study by using the Newcastle–Ottawa Scale (12, 13). We resolved disagreements by discussion or by involving the third author to adjudicate (**Table 1**; **Appendix Table 2**, available at www.annals.org).

Data Synthesis and Analysis

When necessary, we calculated the odds ratio (OR) and 95% CI for dichotomous outcomes, although published adjusted estimates were preferentially used if provided in the report. We pooled data across studies and estimated summary effect sizes by using fixed- and random-effects models. The choice of model was determined by the significance of the maximum likelihood estimate of the heterogeneity parameter (τ^2) (14).

If the estimate of τ^2 did not significantly differ from 0, the fixed-effects model was used (14). We present 2 estimates of heterogeneity—the I^2 statistic and the τ coefficient. Estimates of the former are interpreted as the percentage of variability in effect estimates due to heterogeneity rather than chance, whereas the latter can be interpreted as the clinical heterogeneity as determined by the estimated SD of underlying effects across studies. Unlike the I^2 statistic, the τ coefficient does not change with the number of patients included in the studies in a meta-analysis (15). We used R, version 3.0.0 (R Foundation for Statistical Computing, Vienna, Austria), for statistical analyses. The τ coefficient was measured on the log OR scale.

This review is registered in PROSPERO (CRD42013004469).

RESULTS

Search Results

The database searches yielded 6902 references (**Figure 1**). We removed 2929 duplicates and an additional 2881 clearly irrelevant references. We then identified 2382 records through gray-literature searches. We closely reviewed 3474 titles and abstracts. After this screening, we selected 70 articles for full-text review. We identified an additional 4 studies by cross-referencing bibliographies (16–19). Overall, 15 observational studies met our inclusion criteria.

The **Appendix** shows the disposition of studies excluded after full-text review.

Fourteen of the included studies estimated the odds of suicide in the context of firearm accessibility (6–8, 10, 16–25), and 5 studies estimated the odds of homicide victimization in this context (9, 10, 22–24). Four studies reported both outcomes (10, 22–24).

Study Characteristics

Demographic Characteristics

Persons who completed suicide (mean, 75% [range, 70% to 85%]) (6–8, 10, 16–21, 23) and homicide victims (mean, 79% [range, 63% to 84%]) (9, 10, 23) were more commonly men. Most persons who completed suicide were white (range, 78% to 98%) (6, 8, 10, 16–19, 21, 23, 26), whereas most homicide victims were non-Hispanic black or another race (range, 47% to 62%) (9, 10, 23). Four (28.6%) of the 14 suicide studies were among adolescents only (6, 8, 16, 17), and 10 (71.4%) were among adults only (7, 10, 18–25). All studies of outcomes of homicide victimization were among adults only (9, 10, 22–24).

Firearm Access

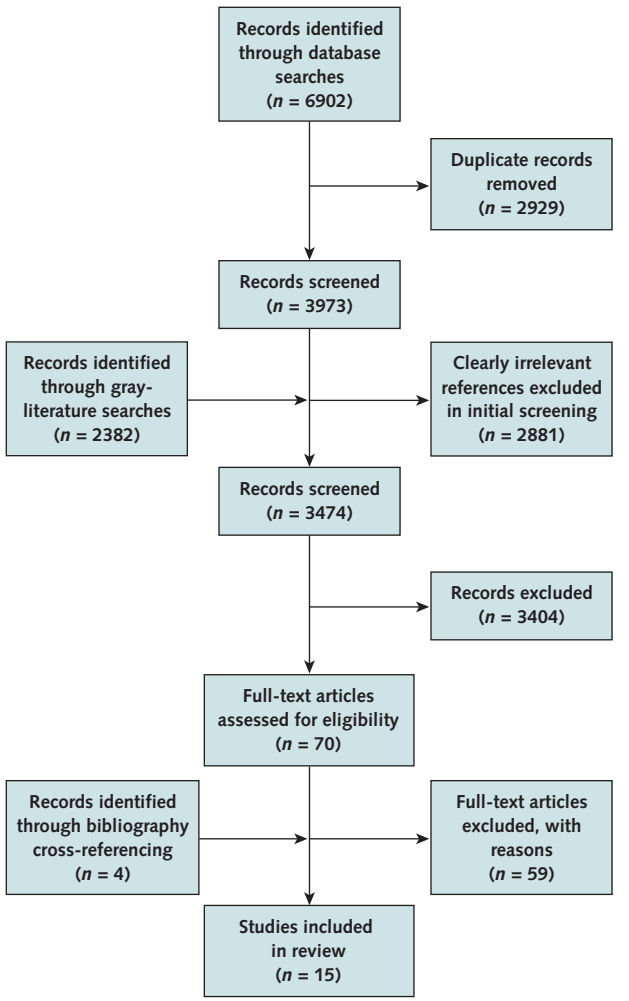
Among 11 U.S. case–control studies using survey data, proportions of firearm access ranged from 62.7% to 75.4% among case patients and from 26.4% to 50.8% among controls participants. One non-U.S. study (20) used survey data to estimate the proportion of case patients (23.9%) and control participants (18.5%) with firearm access, and another non-U.S. study (25) assumed firearm access from military duty and estimated the proportion of case patients (41%) and control participants (17%) with access. Among U.S.-based studies with reported data, the proportion of completed suicides using a firearm ranged from 47% to 73% (6, 7, 10, 16, 17, 21–24); 3 studies did not report adequate data (8, 18, 19).

One non–U.S.-based study of civilians reported that 13% of suicides were completed using a firearm (20), whereas another non-U.S. study of military personnel reported that 52% of suicides were completed using a firearm (25). The proportion of homicides using a firearm ranged from 50% to 76% (13, 15, 27–29).

Studies of Suicide

Eleven of 14 studies (78.6%) interviewed proxies to determine firearm accessibility among decedents or control participants (6–8, 10, 16–21, 23), whereas 3 studies (21.4%) used firearm purchase records or military duty to determine accessibility among decedents or control participants (22, 24, 25) (**Table 2**). Twelve studies (85.7%) defined suicide as self-inflicted, intentional death by any means (6, 7, 10, 16–23, 25), whereas 2 studies (14.3%) defined suicide as injury related only to firearms or firearm- or violence-related injury (8, 24). All suicides were reported consecutively or identified using death certificates. In case–control studies, various types of control participants were identified, such as inpatients who attempted suicide (14.3%) (16, 17), community or school control participants (42.9%) (6–8, 18, 20, 21), decedents from causes other than suicide (28.6%) (18, 19, 24, 25), participants in a national health survey (7.1%) (10), or living HMO-based control participants (7.1%) (22).

Figure 1. **Summary of evidence search and selection.**



Studies of Homicide Victimization

Three of 5 studies (60.0%) interviewed proxies to determine firearm accessibility in the home of decedents or control participants (**Table 1**) (9, 10, 23). Two studies (40.0%) used firearm purchase records to determine firearm accessibility of decedents or control participants (22, 24). In the 3 studies that used survey data, proportions of case patients with firearm access ranged from 30.7% to 45.4% and proportions of control participants ranged from 32.0% to 35.8%. Four studies (80.0%) defined homicide victimization as intentional death by any means, and 1

Table 2. **Characteristics of Included Studies of Suicide and Homicide Victimization**

Study, Year (Reference)	Population	Location	Firearm-Specific Outcomes	Type of Case Patients	Type of Control Participants	Gun Access, %	
						Case Patients	Control Participants
Suicide outcomes							
Brent et al, 1988 (16)	Adolescents	Pennsylvania	55.6% of suicides	Consecutively reported*	Inpatient adolescents who attempted suicide†	74.1	33.9
Brent et al, 1991 (17)	Adolescents	Pennsylvania	69% of suicides	Consecutively reported*	Inpatient adolescents who attempted suicide†	72.3	37.0
Kellermann et al, 1992 (7)	Adults	Tennessee, Washington, Ohio	51%–73% of suicides	Consecutively reported within home*	Community control participants‡	65.0	41.0
Brent et al, 1993 (6)	Adolescents	Pennsylvania	70.2% of suicides	Consecutively reported*	Community control participants†	75.4	50.8
Beautrais et al, 1996 (20)	Adults	New Zealand	13% of suicides	Consecutively reported*	Community control participants	23.9	18.5
Cummings et al, 1997 (22)	Adults	United States	52% of suicides	HMO member cross-referenced with death certificates	HMO member	24.6§	15.1§
Shah et al, 2000 (8)	Adolescents	Colorado	Firearm-only cases	Death certificate*	Students at same school‡	72.0	50.0
Conwell et al, 2002 (21)	Adults >50 y	New York	47.7% of suicides	Consecutively reported*	Community control participants‡	62.7	41.3
Grassel et al, 2003 (24)	Adults	California	47.4% of suicides	Deaths from violence or firearm	Deaths from noninjury causes	8.4§	<1.0§
Kung et al, 2003 (18)	Adults	United States	Any means‖	Deaths determined from death certificate to be suicide*	Deaths determined from death certificate to be natural‡	Men: 69.5 Women: 56.0	Men: 46.8 Women: 32.0
Wiebe, 2003 (10)	Adults	United States	63.5% of suicides	National Mortality Followback Survey data and death certificates*	National Health Interview Survey	65.8	36.7
Dahlberg et al, 2004 (23)	Adults	United States	68% of suicides	Cohort defined using National Mortality Followback Survey data and death certificates¶	Cohort defined using National Mortality Followback Survey data and death certificates¶	72.4	32.0
Kung et al, 2005 (19)	Adults	California	Any means‖	Deaths determined from death certificate to be suicide*	Deaths determined from death certificate to be natural‡	64.2	26.4
Mahon et al, 2005 (25)	Adults	Ireland	52% of suicides	Autopsy reports and death certificates	Deaths from all other causes**	41.0††	17.0††
Homicide victimization outcomes							
Kellermann et al, 1993 (9)	Adults	Tennessee, Washington, Ohio	49.8% of homicides	Serially reported within home*	Community control participants**	45.4	35.8
Cummings et al, 1997 (22)	Adults	United States	56.4% of homicide cases	HMO member cross-referenced with death certificates	HMO member	21.4§	11.9§
Grassel et al, 2003 (24)	Adults	California	66.2% of homicide cases	Deaths from violence or firearm	Deaths from noninjury causes	2.0§	<1.0§
Wiebe, 2003 (10)	Adults	United States	76% of homicide cases	National Mortality Followback Survey data and death certificates*	National Health Interview Survey	30.7	34.0
Dahlberg et al, 2004 (23)	Adults	United States	68% of homicide cases	Cohort defined using National Mortality Followback Survey data and death certificates¶	Cohort defined using National Mortality Followback Survey data and death certificates¶	41.9	32.0

* Proxy interviews.
† Parental figure interviews.
‡ Control participant proxy interviews.
§ Proportion of participants with firearm access determined by gun purchase data.
‖ Unreported percentage.
¶ Proxy interviews of decedents.
** Of determined causes.
†† Proportion of participants with firearm access determined by military duty service time.

defined it as firearm- or violence-related injury (24). All homicides were reported consecutively or identified by using death certificates. In the 4 case–control studies with homicide outcomes, various types of control participants were identified, including community or school control participants (25.0%) (9), nonhomicide decedents (50.0%) (10, 24), or living HMO-based control participants (25.0%) (22).

Control Participant Selection

Three case–control studies had potential selection bias resulting from how control participants were selected (16, 17, 22). Cummings and colleagues (22) used an HMO population as the source of their control participants, whereas 2 other studies used inpatient hospital control participants (16, 17). Using HMO or inpatient hospital control participants can violate principles in control selection—namely, that firearm accessibility for control participants may not be the same as that in the study base (30). This bias may occur when patients use the HMO system or hospital to seek care for suicidal planning with firearms as the means. Two studies (16, 17) are especially prone to the Berkson bias—that is, firearm access is related to inpatient hospitalization due to suicidal planning (31).

Comparability

Five studies of suicide had potential comparability bias resulting from a lack of adequate adjustment for major confounders (for example, history of mental illness) (10, 16, 22, 24, 25). Specifically, 1 study's authors describe significant differences between case patients and control participants with regard to some diagnoses of mental illness, although these are not adjusted for in the model with firearm accessibility (16). Four other studies did not report data on history of mental illness (10, 22, 24, 25). Similarly, 3 studies of homicide victimization had potential comparability bias resulting from a lack of adequate adjustment for major confounders (for example, arrest history of someone in the household) (10, 22, 24). In turn, it was not possible to discern whether domestic violence or arrest history differ between homicide case patients and control participants, which may have resulted in confounding.

Exposure

Eleven of 14 studies of suicide and 2 of 5 studies of homicide had potential exposure bias due to unblinded interviews of proxies of case patients and control participants or differential nonresponse rates between case patients and control participants (6–10, 16–21, 23). Specifically, these studies used surveys to collect data on firearm accessibility; proxies for case patients and control participants knew their case patient or control participant status, thereby potentially biasing recall of firearm accessibility. Finally, although 7 case–control studies reported equal nonresponse rates between case patients and control participants (6, 9, 10, 20, 22, 24, 25), 7 others did not report this (7, 8, 16–19, 21), potentially leading to differential misclassification of firearm exposure.

Meta-analysis of Effects of Guns in the Home

Suicide Outcomes

We pooled data from 14 identified observational studies that assessed the odds of suicide (6–8, 10, 16–25) and, using a random-effects model, calculated a pooled OR of 3.24 (95% CI, 2.41 to 4.40) with substantial heterogeneity ($I^2 = 89\%$; $\tau = 0.45$) (**Figure 2**). All but 1 study (20) found significantly higher odds of suicide among participants who had firearm access than among those who did not, with ORs ranging from 1.38 to 10.38.

Homicide Outcomes

We also pooled data from 5 studies that assessed the odds of homicide (9, 10, 22–24) and, using a random-effects model, estimated a pooled OR of 1.94 (CI, 1.44 to 2.93) with substantial heterogeneity ($I^2 = 66\%$; $\tau = 0.21$) (**Figure 2**). All studies found significantly higher odds of homicide victimization among participants who had access to a firearm than among those who did not, with ORs ranging from 1.41 to 2.70.

Subgroup Analyses

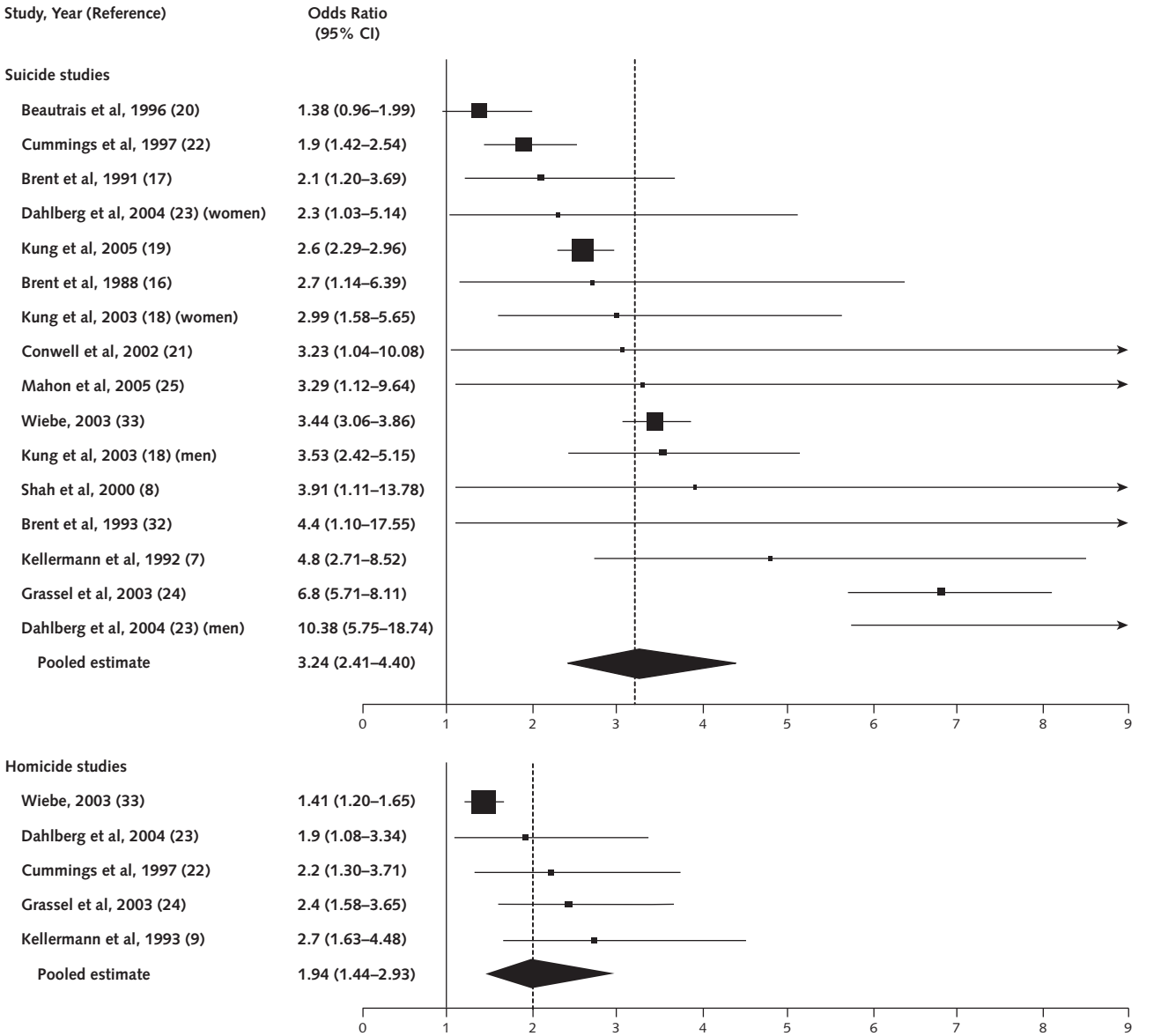
To determine the effect that differences between subgroups had on pooled estimates, we stratified results by sex, age (adolescent or adult), year of publication (before 1997 or 1997 to 2013), location of death (in home only or not in home only), and risk of bias (high or moderate to low) (**Figure 3**). Most tests for interaction between subgroups were not statistically significant, although women had significantly higher odds of homicide victimization than men ($P < 0.001$) and studies with moderate or low risk of bias yielded higher odds of homicide victimization than high-risk studies when firearm access was compared with no access ($P < 0.001$).

Discussion

We performed a systematic review and meta-analysis of all studies that compared the odds of suicide or homicide victimization between persons with and without reported firearm access. All but 1 of the 15 studies identified in this review reported significantly increased odds of death associated with firearm access. We found strong evidence for increased odds of suicide among persons with access to firearms compared with those without access (OR, 3.24 [CI, 2.41 to 4.40]) and moderate evidence for an attenuated increased odds of homicide victimization when persons with and without access to firearms were compared (OR, 1.94 [CI, 1.44 to 2.93]).

Although our study attempts to quantify a person's risk for suicide and homicide in the context of firearm access, many studies have used population-level data to

Figure 2. **Odds of suicide and homicide in the context of firearm access.**



Horizontal lines indicate 95% CIs, squares reflect point estimates, and the size of the squares is proportional to the study's weight. The diamonds reflect the pooled estimate across all studies, and the solid vertical lines reflect the null hypothesis.

describe the public health risk in terms of aggregate firearm ownership (34–48). Reported proportions of U.S. households and persons with access to firearms are the highest in the world (3, 4), whereas rates of firearm-related deaths are among the highest among high-income countries (4).

It has been suggested that higher rates of suicide and homicide in areas with the highest rates of gun availability may indicate impulsivity and ease of locating firearms (37, 49). In addition, although a public health approach to prevention that entails restriction of access to firearms may lead to violent death by other means, the increased rates of violent death (suicide and homicide) in states with the highest rates of firearm access were attributable more to firearm violence than to nonfirearm violence (37).

Sex-specific subgroup analyses suggest that men with access to firearms have statistically nonsignificant higher odds for committing suicide than women (ORs, 3.71 and 3.56, respectively). Moreover, the nonsignificant pooled OR of suicide among women when firearm access was compared suggests that evidence of an increased risk for suicide among women may not be very strong when all of the available literature is considered. Recent research that found that women are less likely to achieve suicide completion by firearm or hanging and are nearly 4 times more

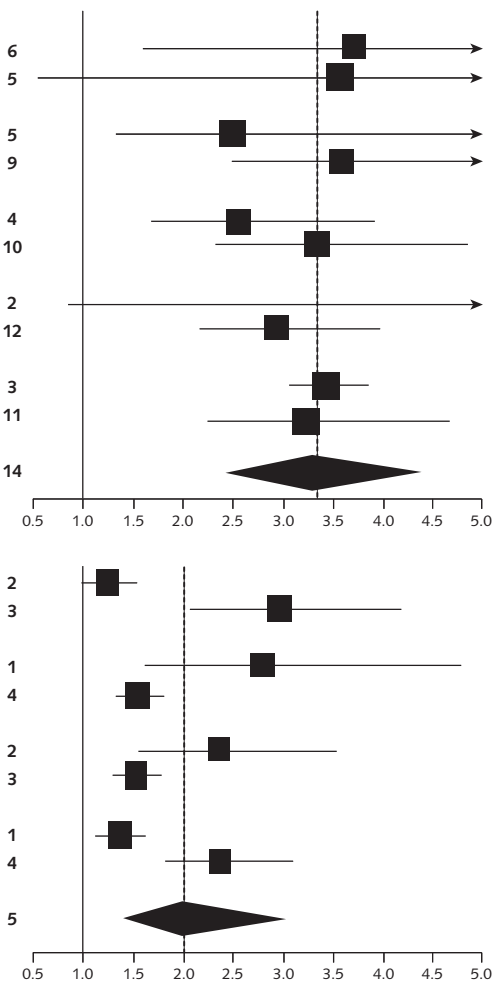
likely to use poison than men (OR, 3.65 [CI, 1.87 to 7.09]) (50) seems to support these findings.

Although men with access to firearms may have higher odds of committing suicide than women, women have higher odds of homicide victimization. The tests for interaction between sex subgroups in our meta-analysis were significant in fixed-effects models ($P < 0.001$). Although men account for more than three quarters of all suicides and homicides, women with firearm access have a higher risk for homicide victimization, a finding that previous studies support (9, 10). Of note, in our review, homicide was the result of victimization rather than perpetration. Furthermore, empirical evidence suggests that most homicide victims know their assailant (10, 24), which suggests an interpersonal dispute within the household or other domestic violence and not an unknown intruder.

Our results suggest that the pooled OR of suicide is similar between adults and adolescents (ORs, 3.34 and 2.56, respectively; P value for interaction = 0.31). To determine the extent to which data from firearm purchases or military duty contribute to the effects seen among adults, we performed a sensitivity analysis that excluded studies with those data; the pooled OR for suicide among adults was slightly decreased (3% reduction; pooled OR, 3.25) in this analysis. We performed an additional sensitivity analysis that excluded the remaining non-U.S. study, and the

Figure 3. **Meta-analyses estimating the odds of suicide and homicide between subgroups.**

Characteristic	Odds Ratio (95% CI)	Heterogeneity (I^2), %	Heterogeneity (τ)*	Studies, *n*
Suicide studies				
Men	3.71 (1.61–9.00)	93	0.72	6
Women	3.56 (0.53–21.12)	94	1.26	5
Before 1997	2.49 (1.34–5.36)	72	0.40	5
1997–2013	3.58 (2.49–5.16)	91	0.43	9
Adolescents†	2.56 (1.68–3.90)	0	0.00	4
Adults	3.34 (2.31–4.85)	92	0.49	10
Only in home	5.11 (0.85–28.69)	78	0.49	2
Not only in home	2.93 (2.16–3.97)	91	0.40	12
High risk of bias†	3.43 (3.06–3.85)	0	0.00	3
Moderate/low risk of bias	3.23 (2.25–4.66)	92	0.50	11
Pooled estimate	3.24 (2.41–4.40)	89	0.45	14
Homicide studies				
Men†	1.29 (1.07–1.55)	65	0.00	2
Women†	2.84 (2.05–3.94)	0	0.00	3
Before 1997	2.70 (1.63–4.48)	NA‡	NA‡	1
1997–2013†	1.57 (1.37–1.80)	61	0.18	4
Only in home†	2.31 (1.58–3.36)	0	0.00	2
Not only in home†	1.55 (1.35–1.79)	72	0.20	3
High risk of bias	1.41 (1.20–1.65)	NA‡	NA‡	1
Moderate/low risk of bias†	2.31 (1.81–2.96)	0	0.00	4
Pooled estimate	1.94 (1.44–2.93)	66	0.21	5



Horizontal lines indicate 95% CIs, squares reflect point estimates, the diamonds reflect the pooled estimate across all studies, and the solid vertical lines reflect the null hypothesis. The τ estimate was not reported in fixed-effects models. NA = not applicable.
* The τ estimate is on the log odds ratio scale.
† Fixed-effects models.
‡ No meta-analysis was performed.

pooled OR increased slightly (9% increase; pooled OR, 3.64). Tests for interactions among age subgroups remained nonsignificant ($P = 0.170$), although estimates for adults were more than 40% higher than those for adolescents. Accessibility may explain part of the difference in risk between adults and adolescents; adults typically purchase and store the firearms, and improper storage practices pose a serious risk because they have been previously associated with adolescent suicide (51).

The availability of firearms in the home may not be the catalyst for suicidal ideation, but firearms may be a preferred method of suicide among those who have suicidal thoughts. Betz and colleagues (52) found that adolescents with firearm access were no more likely to have suicidal thoughts or a suicide plan in the past 12 months than those without firearm access. However, among adolescents with a suicide plan, those with a firearm in the home were more than 7 times more likely to have a plan involving firearms than those without a firearm in the home (OR, 7.39 [CI, 2.04 to 26.84]) (52).

Since 1996, federal law has prohibited U.S. Department of Health and Human Services agencies from using funds for research that could be interpreted as promoting or advocating for gun control (53). Although we anticipated a lower absolute number of studies since 1996, we found that 60% of all studies ($n = 9$) were published from 1997 to 2013 compared with 40% published before 1997. Similarly, a recent study of publication rates of studies of firearm-related death among youths found an increase in publications (54). The investigators found that, although the rates of publication increased, the relative increase was lower than among publications of other leading causes of death among youths, and models exploring the effects of the federal law passed in 1996 did not suggest a temporal pattern in publication (54).

We also stratified our pooled results by risk of bias and found no significant difference between studies with high risk and those with moderate or low risk (ORs, 3.43 and 3.23, respectively). To the extent that we measured bias in the studies of suicide, we were not able to detect any influence of these biases in the pooled results. Among studies with only moderate or low risk of bias that evaluated the effect of firearm ownership on homicide, the pooled OR was 2.31 (CI, 1.81 to 2.96), which is 19% higher than the pooled OR that included all studies, suggesting that the higher bias in homicide studies may trend estimates toward the null.

Our review has limitations. First, our conclusions are only as good as the data and studies that we identified. To minimize this limitation, we searched extensively by using standardized search strategies from the Cochrane Collaboration to identify all relevant studies. Studies of death commonly have a case–control design, although the cohort study included in our meta-analysis found results similar to those of the case–control studies. In addition, although we limited our analysis to individual-level data, we acknowledge that several available ecological studies have also explored the link between firearms and violent death (5, 55). Among other concerns, we decided not to include population-level data because we were concerned about ecological bias; for example, gun ownership data on a population level may not reflect the persons who actually commit suicide, so no true link between gun ownership and harms outcomes can be made. Despite their limitations, individual-level data, such as those we included in this study, are ideal because confounding and explanatory reasons for the relationship among firearms and suicide and homicide can be better explored.

Second, misclassification of firearm exposure and cause of death is a potential risk in included studies. Although all studies of homicide were among adults, causes of firearm-related deaths are inconsistently reported as homicide or accidental, particularly among children (56). In fact, in some cases, accidental firearm-related deaths among children may be classified as homicide due to an unsecured firearm or as a result of a medical examiner's decision that any death resulting from 1 person shooting another, regardless of intent, is a homicide (56). Further, to determine firearm availability, proxies were interviewed in 79% of studies evaluating suicide outcomes and 60% evaluating homicide outcomes. However, evidence suggests apparent differences between sexes in describing firearm ownership or firearm storage within the same household (57, 58). In fact, husbands are most often acknowledged by both men and women to be the person responsible for firearm storage and ownership (58), a sex gap that may introduce selection bias in proxy interviews.

Third, we synthesized heterogeneous populations of varying risks to estimate pooled ORs of death. We analyzed our pooled data by using fixed- and random-effects models but note that fixed-effects models only marginally changed pooled effects in the suicide outcomes and all models retained statistical significance. Specifically, when fixed-effects models were used instead of random-effects models, the pooled ORs changed from 3.24 to 3.32 for suicide and from 1.94 to 1.63 for homicide. Moreover, for the 11 U.S. studies that used survey data to classify firearm exposure, proportions of case patients with gun access were closely related, ranging from 62.7% to 75.4%. The reported proportions of control participants with gun access varied more, from 26.4% to 50.8%. Perhaps as a reflection of different firearm ownership culture or restrictions, the only non-U.S. study in a civilian population used survey data and estimated the proportions of suicide case patients and control participants with firearm access to be considerably lower than those in U.S. studies (23.9% and 18.5%, respectively) (20).

Fourth, we considered studies of suicide and homicide victimization by any means, and firearm-specific outcomes may differ. In addition to the other differences between U.S. and non-U.S. studies, 47% to 73% of suicide cases in the United States were firearm-specific compared with only

13% of cases in the study of non-U.S. civilians (20). When considering suicides by nonfirearm methods in the identified literature, researchers have generally found reduced odds of suicide completion by any means other than a firearm, comparing firearm accessibility (OR range, 0.68 to 0.90) (7, 10, 22, 24). Among homicide victimization studies, none reported a significant finding for homicides that are not firearm-specific, although the proportion of homicides in which firearms was used ranged from 50% to 76% (9, 10, 22–24).

Fifth, in studies with homicide outcomes, whether the presence of a firearm among case patients is the result of environmental characteristics or living conditions is unclear. For example, some persons may purchase a firearm for protection because of neighborhood crime, which then translates the risk from the ownership of a firearm to the neighborhood. Also, in homicides, the case patients are by definition deceased and injuries due to firearms may be more lethal than other means; thus, assault by other means would be less likely to be captured (59).

Finally, other sources of bias are an ever-present threat. Among them, using firearm purchase data or military duty as a proxy for firearm access or ownership may not accurately represent ownership. The pooled OR for suicide in our random-effects meta-analyses with data from firearm purchase or military duty was only 3.2% higher than the pooled OR without these studies (3.24 and 3.14, respectively). In contrast, the pooled OR for homicide in the random-effects meta-analyses with firearm purchase data was 27.6% higher than the pooled OR (fixed-effects) without these studies (1.94 and 1.52, respectively), although this is probably partly an artifact of model specification. Finally, although publication bias is a concern, the Egger regression tests for asymmetry of the funnel plot (27) for suicide studies were not significant ($P = 0.88$). However, we identified too few studies of homicide to reasonably assess publication bias.

In summary, we found the association between firearm availability and homicide to be more modest than that between firearm availability and completed suicide. Future studies of firearm access and homicide risk should focus on the role that social factors and surrounding living conditions play in homicide victimization. Furthermore, the National Research Council has acknowledged the difficulty in establishing firearm ownership in studies because of privacy and questionable legality concerns (28). As such, it recommended that researchers receive adequate access to data to trace firearms (28). Future studies of the effect of firearms used in violent injuries may, as a result, have a lower risk for misclassification of firearm ownership and yield more methodologically robust results. Nonetheless, the evidence that we synthesize here helps to elucidate the risks of having a firearm in the home; restricting that access may effectively prevent injury (29).

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References

1. **Centers for Disease Control and Prevention.** Injury Prevention & Control: Data & Statistics (WISQARS). Atlanta, GA: Centers for Disease Control and Prevention; 2013. Accessed at www.cdc.gov/injury/wisqars/index.html on 20 August 2013.

2. **Karch DL, Logan J, McDaniel D, Parks S, Patel N; Centers for Disease Control and Prevention (CDC).** Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2009. MMWR Surveill Summ. 2012; 61(6):1-43. [PMID: 22971797]

3. **Smith TW; National Opinion Research Center/University of Chicago.** Public Attitudes towards the Regulation of Firearms. March 2007. Accessed at www.norc.org/PDFs/publications/SmithT_Public_Attitudes_Firearms_2007.pdf on 23 August 2013.

4. **Krug EG, Powell KE, Dahlberg LL.** Firearm-related deaths in the United States and 35 other high- and upper-middle-income countries. Int J Epidemiol. 1998;27:214-21. [PMID: 9602401]

5. **Fleegler EW, Lee LK, Monuteaux MC, Hemenway D, Mannix R.** Firearm legislation and firearm-related fatalities in the United States. JAMA Intern Med. 2013;173:732-40. [PMID: 23467753]

6. **Brent DA, Perper JA, Moritz G, Baugher M, Schweers J, Roth C.** Firearms and adolescent suicide. A community case-control study. Am J Dis Child. 1993; 147:1066-71. [PMID: 8213677]

7. **Kellermann AL, Rivara FP, Somes G, Reay DT, Francisco J, Banton JG, et al.** Suicide in the home in relation to gun ownership. N Engl J Med. 1992; 327:467-72. [PMID: 1308093]

8. **Shah S, Hoffman RE, Wake L, Marine WM.** Adolescent suicide and household access to firearms in Colorado: results of a case-control study. J Adolesc Health. 2000;26:157-63. [PMID: 10706163]

9. **Kellermann AL, Rivara FP, Rushforth NB, Banton JG, Reay DT, Francisco JT, et al.** Gun ownership as a risk factor for homicide in the home. N Engl J Med. 1993;329:1084-91. [PMID: 8371731]

10. **Wiebe DJ.** Homicide and suicide risks associated with firearms in the home: a national case-control study. Ann Emerg Med. 2003;41:771-82. [PMID: 12764330]

11. **Higgins JPT, Green S.** Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0. The Cochrane Collaboration; 2011. Accessed at www.cochrane-handbook.org on 23 August 2013.

12. **Wells G, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al.** The Newcastle–Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa, Ontario, Canada: Ottawa Hospital Research Institute; 2013. Accessed at www.ohri.ca/programs/clinical_epidemiology/oxford.asp on 23 August 2013.

13. **Wells G, Brodsky L, O'Connell D, Shea B, Henry D, Mayank S, et al.** An evaluation of the Newcastle Ottawa Scale: an assessment tool for evaluating the quality of non-randomized studies [Abstract]. Presented at XI Cochrane Colloquium: Evidence, Health Care and Culture, Barcelona, Spain, 26–31 October 2003. Abstract no. 26.

14. **Guolo A, Varin C.** The R package metaLik for likelihood inference in meta-analysis. J Stat Softw. 2012;50:1-14.

15. **Rücker G, Schwarzer G, Carpenter JR, Schumacher M.** Undue reliance on I(2) in assessing heterogeneity may mislead. BMC Med Res Methodol. 2008;8:79. [PMID: 19036172]
16. **Brent DA, Perper JA, Goldstein CE, Kolko DJ, Allan MJ, Allman CJ, et al.** Risk factors for adolescent suicide. A comparison of adolescent suicide victims with suicidal inpatients. Arch Gen Psychiatry. 1988;45:581-8. [PMID: 3377645]
17. **Brent DA, Perper JA, Allman CJ, Moritz GM, Wartella ME, Zelenak JP.** The presence and accessibility of firearms in the homes of adolescent suicides. A case-control study. JAMA. 1991;266:2989-95. [PMID: 1820470]
18. **Kung HC, Pearson JL, Liu X.** Risk factors for male and female suicide decedents ages 15-64 in the United States. Results from the 1993 National Mortality Followback Survey. Soc Psychiatry Psychiatr Epidemiol. 2003;38:419-26. [PMID: 12910337]
19. **Kung HC, Pearson JL, Wei R.** Substance use, firearm availability, depressive symptoms, and mental health service utilization among white and African American suicide decedents aged 15 to 64 years. Ann Epidemiol. 2005;15:614-21. [PMID: 16118006]
20. **Beautrais AL, Joyce PR, Mulder RT.** Access to firearms and the risk of suicide: a case control study. Aust N Z J Psychiatry. 1996;30:741-8. [PMID: 9034462]
21. **Conwell Y, Duberstein PR, Connor K, Eberly S, Cox C, Caine ED.** Access to firearms and risk for suicide in middle-aged and older adults. Am J Geriatr Psychiatry. 2002;10:407-16. [PMID: 12095900]
22. **Cummings P, Koepsell TD, Grossman DC, Savarino J, Thompson RS.** The association between the purchase of a handgun and homicide or suicide. Am J Public Health. 1997;87:974-8. [PMID: 9224179]
23. **Dahlberg LL, Ikeda RM, Kresnow MJ.** Guns in the home and risk of a violent death in the home: findings from a national study. Am J Epidemiol. 2004;160:929-36. [PMID: 15522849]
24. **Grassel KM, Wintemute GJ, Wright MA, Romero MP.** Association between handgun purchase and mortality from firearm injury. Inj Prev. 2003;9:48-52. [PMID: 12642559]
25. **Mahon MJ, Tobin JP, Cusack DA, Kelleher C, Malone KM.** Suicide among regular-duty military personnel: a retrospective case-control study of occupation-specific risk factors for workplace suicide. Am J Psychiatry. 2005;162:1688-96. [PMID: 16135629]
26. **Brent DA, Baugher M, Bridge J, Chen T, Chiappetta L.** Age- and sex-related risk factors for adolescent suicide. J Am Acad Child Adolesc Psychiatry. 1999;38:1497-505. [PMID: 10596249]
27. **Thornton A, Lee P.** Publication bias in meta-analysis: its causes and consequences. J Clin Epidemiol. 2000;53:207-16. [PMID: 10729693]
28. **Wellford C, Pepper J, Petrie C.** Firearms and Violence: A Critical Review. Washington, DC: National Academies Pr; 2004.
29. **Rodríguez Andrés A, Hempstead K.** Gun control and suicide: the impact of state firearm regulations in the United States, 1995-2004. Health Policy. 2011;101:95-103. [PMID: 21044804]
30. **Wacholder S, Silverman DT, McLaughlin JK, Mandel JS.** Selection of controls in case-control studies. II. Types of controls. Am J Epidemiol. 1992;135:1029-41. [PMID: 1595689]
31. **Flanders WD, Boyle CA, Boring JR.** Bias associated with differential hospitalization rates in incident case-control studies. J Clin Epidemiol. 1989;42:395-401. [PMID: 2732768]
32. **Brent DA, Perper J, Moritz G, Baugher M, Allman C.** Suicide in adolescents with no apparent psychopathology. J Am Acad Child Adolesc Psychiatry. 1993;32:494-500. [PMID: 8496111]
33. **Wiebe DJ.** Firearms in US homes as a risk factor for unintentional gunshot fatality. Accid Anal Prev. 2003;35:711-6. [PMID: 12850071]
34. **Alphey RS, Leach SJ.** Accidental death in the home. R Soc Health J. 1974;94:97-102. [PMID: 4428029]
35. **Cherry D, Annest JL, Mercy JA, Kresnow M, Pollock DA.** Trends in nonfatal and fatal firearm-related injury rates in the United States, 1985-1995. Ann Emerg Med. 1998;32:51-9. [PMID: 9656949]
36. **Hepburn L, Azrael D, Miller M, Hemenway D.** The effect of child access prevention laws on unintentional child firearm fatalities, 1979-2000. J Trauma. 2006;61:423-8. [PMID: 16917460]
37. **Miller M, Azrael D, Hemenway D.** Firearm availability and suicide, homicide, and unintentional firearm deaths among women. J Urban Health. 2002;79:26-38. [PMID: 11937613]
38. **Miller M, Lippmann SJ, Azrael D, Hemenway D.** Household firearm ownership and rates of suicide across the 50 United States. J Trauma. 2007;62:1029-34. [PMID: 17426563]
39. **Murnan J, Dake JA, Price JH.** Association of selected risk factors with variation in child and adolescent firearm mortality by state. J Sch Health. 2004;74:335-40. [PMID: 15554120]
40. **Schwartz AJ.** Rate, relative risk, and method of suicide by students at 4-year colleges and universities in the United States, 2004-2005 through 2008-2009. Suicide Life Threat Behav. 2011;41:353-71. [PMID: 21535095]
41. **Sillito CL, Salari S.** Child outcomes and risk factors in U.S. homicide-suicide cases 1999–2004. J Fam Violence. 2011;26:285-97.
42. **Webster DW, Starnes M.** Reexamining the association between child access prevention gun laws and unintentional shooting deaths of children. Pediatrics. 2000;106:1466-9. [PMID: 11099605]
43. **Wintemute GJ, Parham CA, Beaumont JJ, Wright M, Drake C.** Mortality among recent purchasers of handguns. N Engl J Med. 1999;341:1583-9. [PMID: 10564689]
44. **Nance ML, Carr BG, Kallan MJ, Branas CC, Wiebe DJ.** Variation in pediatric and adolescent firearm mortality rates in rural and urban US counties. Pediatrics. 2010;125:1112-8. [PMID: 20498168]
45. **Richardson EG, Hemenway D.** Homicide, suicide, and unintentional firearm fatality: comparing the United States with other high-income countries, 2003. J Trauma. 2011;70:238-43. [PMID: 20571454]
46. **Large MM, Nielssen OB.** Suicide in Australia: meta-analysis of rates and methods of suicide between 1988 and 2007. Med J Aust. 2010;192:432-7. [PMID: 20402605]
47. **Caron J, Julien M, Huang JH.** Changes in suicide methods in Quebec between 1987 and 2000: the possible impact of bill C-17 requiring safe storage of firearms. Suicide Life Threat Behav. 2008;38:195-208. [PMID: 18444777]
48. **Branas CC, Richmond TS, Culhane DP, Ten Have TR, Wiebe DJ.** Investigating the link between gun possession and gun assault. Am J Public Health. 2009;99:2034-40. [PMID: 19762675]
49. **Browning CH.** Handguns and homicide. A public health problem. JAMA. 1976;236:2198-200. [PMID: 989812]
50. **Callanan VJ, Davis MS.** Gender differences in suicide methods. Soc Psychiatry Psychiatr Epidemiol. 2012;47:857-69. [PMID: 21604180]
51. **Grossman DC, Mueller BA, Riedy C, Dowd MD, Villaveces A, Prodzinski J, et al.** Gun storage practices and risk of youth suicide and unintentional firearm injuries. JAMA. 2005;293:707-14. [PMID: 15701912]
52. **Betz ME, Barber C, Miller M.** Suicidal behavior and firearm access: results from the second injury control and risk survey. Suicide Life Threat Behav. 2011;41:384-91. [PMID: 21535097]
53. Consolidated Appropriations Act of 2011, Pub. L. No. 112-74, § 218 (2011).
54. **Ladapo JA, Rodwin BA, Ryan AM, Trasande L, Blustein J.** Scientific publications on firearms in youth before and after Congressional action prohibiting federal research funding. JAMA. 2013;310:532-4. [PMID: 23925624]
55. **Miller M, Hemenway D, Azrael D.** State-level homicide victimization rates in the US in relation to survey measures of household firearm ownership, 2001-2003. Soc Sci Med. 2007;64:656-64. [PMID: 17070975]
56. **Luo M, McIntire M.** Children and guns: the hidden toll. New York Times. 29 September 2013:A1.
57. **Ludwig J, Cook PJ, Smith TW.** The gender gap in reporting household gun ownership. Am J Public Health. 1998;88:1715-8. [PMID: 9807545]
58. **Coyne-Beasley T, Baccaglini L, Johnson RM, Webster B, Wiebe DJ.** Do partners with children know about firearms in their home? Evidence of a gender gap and implications for practitioners. Pediatrics. 2005;115:e662-7. [PMID: 15930193]
59. **Saltzman LE, Mercy JA, O'Carroll PW, Rosenberg ML, Rhodes PH.** Weapon involvement and injury outcomes in family and intimate assaults. JAMA. 1992;267:3043-7. [PMID: 1588718]

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Appendix: The Accessibility of Firearms and Risk for Suicide and Homicide Victimization Among Household Members

Search Strategy

One investigator reviewed the titles and abstracts identified in the initial search to assess potential relevance to the topic. After removing irrelevant titles, 2 investigators independently read the titles, abstracts, and descriptor terms of the remaining citations to identify eligible reports. We obtained full-text articles for all citations identified as potentially eligible, and 2 investigators independently determined the relevance of the articles according to our inclusion criteria.

When there was uncertainty about a study's eligibility, we obtained the full-text article. The 2 investigators independently applied the inclusion criteria, and any differences were resolved by discussion with the third investigator. We reviewed studies for relevance based on design, types of participants, and outcome measures.

Disposition of Excluded Studies After Full-Text Review

Of the full-text articles that we reviewed, 3 were excluded because the study populations were contained in previously published data included in this review (26, 32, 60), 16 were ecological studies comparing aggregate data between populations (34–47, 61, 62), 15 were only descriptive (2, 52, 63–76), 2 estimated only the victimization rates (nonfatal) of firearm owners (48, 76), 3 were reviews (77–79), 7 did not evaluate our selected harms outcomes (80–86), 7 studied only unintentional firearm death (33, 87–92), 1 did not evaluate firearm access (93), and 4 were editorials (94–97). Overall, 15 observational studies met our inclusion criteria.

Appendix Table 1. **Search Strategy**

Core terms of PubMed search strategy, adapted as needed for use in other databases; initial search on 22 May 2013
(home*[tiab] OR house*[tiab] OR household*[tiab]) AND (Firearms[mh] OR Weapons[mh] OR Wounds, Gunshot[mh] OR firearm*[tiab] OR gun*[tiab] OR handgun*[tiab] OR rifle*[tiab] OR shotgun*[tiab])
individual database yields:
PubMed (n = 944)
EMBASE (n = 35)
Cochrane Central Register of Controlled Trials (n = 16)
Web of Science (n = 797)

Updated; additional search on 23 August 2013
(Accidents[mh] OR Homicide[mh] OR Suicide[mh] OR accident*[tiab] OR homicide*[tiab] OR suicide*[tiab]) AND (Firearms[mh] OR Weapons[mh] OR Wounds, Gunshot[mh] OR firearm*[tiab] OR gun*[tiab] OR handgun*[tiab] OR rifle*[tiab] OR shotgun*[tiab])

Terms of gray-literature search strategy
Gray literature search date: 25 August 2013
Publications, reports, and working papers from the following agencies and institutes:
1) Small Arms Survey publications (www.smallarmssurvey.org)
2) Violence Policy Center (www.vpc.org)
3) University of Colorado-Boulder Center for the Study and Prevention of Violence (www.colorado.edu/cspv)
4) Harvard Injury Control Research Center (www.hsph.harvard.edu/hicrc)
5) Firearm and Injury Center at Penn (www.uphs.upenn.edu/ficap)
6) University of California, Davis, Violence Prevention Research Program (www.ucdmc.ucdavis.edu/vprp)

Google searches of the following sites using these terms:
7) American Public Health Association (guns site:apha.org filetype:pdf)
8) American Psychological Association (guns site:apa.org filetype:pdf)
9) Centers for Disease Control and Prevention (guns site:cdc.gov filetype:pdf)
10) National Institute of Justice (guns site:nij.gov filetype:pdf)

Appendix Table 2. **Detailed Risk of Bias Results Using the Newcastle–Ottawa Scale for Assessing Quality for Observational Studies**

Study, Year (Reference)	Selection Criteria				Comparability		Exposure			
	Adequate Case Definition With Independent Validation	Consecutive or Obviously Representative Series of Cases	Selection of Community Control Participants	Control Participants Defined by No History of Studied End Point	Comparability of Case Patients and Control Participants (Design/Analysis)		Ascertainment of Exposure		Same Ascertainment Method for Case Patients and Control Participants	Nonresponse Rate Same for Both Groups
					Controls for Mental Illness History	Controls for Age or Sex	Secure Record	Blinded Inter-views		
Homicide victimization outcomes										
Wiebe, 2003 (10)	√	√	√	√		√				√
Grassel et al, 2003 (24)	√	√	√	√		√	√		√	√
Cummings et al, 1997 (22)	√	√		√		√	√		√	√
Kellermann et al, 1993 (9)	√	√	√	√	√	√			√	√
Suicide outcomes										
Mahon et al, 2005 (25)	√	√	√	√		√	√		√	√
Brent et al, 1988 (16)	√	√		√		√			√	
Brent et al, 1991 (17)	√	√		√	√	√			√	
Kellermann et al, 1992 (7)	√	√	√	√	√	√			√	
Brent et al, 1993 (6)	√	√	√	√	√	√			√	√
Beautrais et al, 1996 (20)	√	√	√	√	√	√			√	√
Cummings et al, 1997 (22)	√	√		√		√	√		√	√
Shah et al, 2000 (8)	√	√	√	√	√	√			√	
Conwell et al, 2002 (21)	√	√	√	√	√	√			√	
Grassel et al, 2003 (24)	√	√	√	√		√	√		√	√
Kung et al, 2005 (19)	√	√	√	√	√	√			√	
Wiebe, 2003 (10)	√	√	√	√		√				√
Kung et al, 2003 (18)	√	√	√	√	√	√			√	

60. **Bailey JE, Kellermann AL, Somes GW, Banton JG, Rivara FP, Rushforth NP.** Risk factors for violent death of women in the home. Arch Intern Med. 1997;157:777-82. [PMID: 9125010]
61. **Wiebe DJ, Krafty RT, Koper CS, Nance ML, Elliott MR, Branas CC.** Homicide and geographic access to gun dealers in the United States. BMC Public Health. 2009;9:199. [PMID: 19549293]
62. **Branas CC, Nance ML, Elliott MR, Richmond TS, Schwab CW.** Urban-rural shifts in intentional firearm death: different causes, same results. Am J Public Health. 2004;94:1750-5. [PMID: 15451745]
63. **Beaver BL, Moore VL, Peclet M, Haller JA Jr, Smialek J, Hill JL.** Characteristics of pediatric firearm fatalities. J Pediatr Surg. 1990;25:97-9. [PMID: 2299552]
64. **Bretsky PM, Blanc DC, Phelps S, Ransom JA, Degutis LC, Groce NE.** Epidemiology of firearm mortality and injury estimates: state of Connecticut, 1988-1993. Ann Emerg Med. 1996;28:176-82. [PMID: 8759582]
65. **Campbell BT, Radisch DL, Phillips JD, von Allmen D.** From gunstore to smoking gun: tracking guns that kill children in North Carolina. J Pediatr Surg. 2004;39:1874-6. [PMID: 15616955]
66. **Fraga AM, Fraga GP, Stanley C, Costantini TW, Coimbra R.** Children at danger: injury fatalities among children in San Diego County. Eur J Epidemiol. 2010;25:211-7. [PMID: 20084430]
67. **Ismach RB, Reza A, Ary R, Sampson TR, Bartolomeos K, Kellermann AL.** Unintended shootings in a large metropolitan area: an incident-based analysis. Ann Emerg Med. 2003;41:10-7. [PMID: 12514677]
68. **Johnson RM, Barber C, Azrael D, Clark DE, Hemenway D.** Who are the owners of firearms used in adolescent suicides? Suicide Life Threat Behav. 2010; 40:609-11. [PMID: 21198329]
69. **Senger C, Keijzer R, Smith G, Muensterer OJ.** Pediatric firearm injuries: a 10-year single-center experience of 194 patients. J Pediatr Surg. 2011;46:927-32. [PMID: 21616254]
70. **Kellermann AL, Reay DT.** Protection or peril? An analysis of firearm-related deaths in the home. N Engl J Med. 1986;314:1557-60. [PMID: 3713749]
71. **Klein SD, Bischoff C, Schweitzer W.** Suicides in the Canton of Zurich (Switzerland). Swiss Med Wkly. 2010;140:w13102. [PMID: 22052542]
72. **Molina DK, Dimaio VJ.** Trends in firearm usage in homicides and suicides in Bexar County Texas from 1982 to 2004. Am J Forensic Med Pathol. 2008; 29:281-4. [PMID: 19259009]
73. **Uzun I, Karayel FA, Akyildiz EU, Turan AA, Toprak S, Arpak BB.** Suicide among children and adolescents in a province of Turkey. J Forensic Sci. 2009; 54:1097-100. [PMID: 19686393]
74. **Azrael D, Hemenway D, Miller M, Barber CW, Schackner R.** Youth suicide: insights from 5 years of Arizona Child Fatality Review Team data. Suicide Life Threat Behav. 2004;34:36-43. [PMID: 15106886]
75. **Kaplan MS, McFarland BH, Huguet N.** Firearm suicide among veterans in the general population: findings from the national violent death reporting system. J Trauma. 2009;67:503-7. [PMID: 19741391]
76. **Ruback RB, Shaffer JN, Clark VA.** Easy access to firearms: juveniles' risks for violent offending and violent victimization. J Interpers Violence. 2011;26:2111-38. [PMID: 20724298]
77. **Dowd MD, Sege RD; Council on Injury, Violence, and Poison Prevention Executive Committee.** Firearm-related injuries affecting the pediatric population. Pediatrics. 2012;130:e1416-23. [PMID: 23080412]
78. **Cummings P, Koepsell TD.** Does owning a firearm increase or decrease the risk of death? JAMA. 1998;280:471-3. [PMID: 9701087]
79. **Brent DA, Bridge J.** Firearms availability and suicide: evidence, interventions, and future directions. Am Behav Sci. 2003;46:1192-210.
80. **Grossman DC, Reay DT, Baker SA.** Self-inflicted and unintentional firearm injuries among children and adolescents: the source of the firearm. Arch Pediatr Adolesc Med. 1999;153:875-8. [PMID: 10437764]
81. **Wintemute GJ.** Association between firearm ownership, firearm-related risk and risk reduction behaviours and alcohol-related risk behaviours. Inj Prev. 2011; 17:422-7. [PMID: 21670071]
82. **Miller M, Barber C, Azrael D, Hemenway D, Molnar BE.** Recent psychopathology, suicidal thoughts and suicide attempts in households with and without firearms: findings from the National Comorbidity Study Replication. Inj Prev. 2009;15:183-7. [PMID: 19494098]
83. **Sauaia A, Miller JI, Moore EE, Partrick D.** Firearm injuries of children and adolescents in 2 Colorado trauma centers: 2000-2008. JAMA. 2013;309:1683-5. [PMID: 23613070]
84. **Li G, Baker SP, DiScala C, Fowler C, Ling J, Kelen GD.** Factors associated with the intent of firearm-related injuries in pediatric trauma patients. Arch Pediatr Adolesc Med. 1996;150:1160-5. [PMID: 8904856]
85. **Li G, Ling J, DiScala C, Nordenholz K, Sterling S, Baker SP.** Characteristics and outcomes of self inflicted pediatric injuries: the role of method of suicide attempt. Inj Prev. 1997;3:115-9. [PMID: 9213157]
86. **Sing RF, Branas CC, MacKenzie EJ, Schwab CW.** Geographic variation in serious nonfatal firearm injuries in Pennsylvania. J Trauma. 1997;43:825-30. [PMID: 9390496]
87. **Rausch TK, Sanddal ND, Sanddal TL, Esposito TJ.** Changing epidemiology of injury-related pediatric mortality in a rural state: implications for injury control. Pediatr Emerg Care. 1998;14:388-92. [PMID: 9881980]
88. **Morrow PL, Hudson P.** Accidental firearm fatalities in North Carolina, 1976-80. Am J Public Health. 1986;76:1120-3. [PMID: 3740337]
89. **Rushforth NB, Hirsch CS, Ford AB, Adelson L.** Accidental firearm fatalities in a metropolitan county (1958-1973). Am J Epidemiol. 1974;100:499-505. [PMID: 4447111]
90. **Svenson JE, Spurlock C, Nypaver M.** Pediatric firearm-related fatalities. Not just an urban problem. Arch Pediatr Adolesc Med. 1996;150:583-7. [PMID: 8646306]
91. **Martin JR, Sklar DP, McFeeley P.** Accidental firearm fatalities among New Mexico children. Ann Emerg Med. 1991;20:58-61. [PMID: 1984730]
92. **Carr BG, Nance ML, Branas CC, Wolff CS, Kallan MJ, Myers SR, et al.** Unintentional firearm death across the urban-rural landscape in the United States. J Trauma Acute Care Surg. 2012;73:1006-10. [PMID: 22976424]
93. **Christoffel KK, Marcus D, Sagerman S, Bennett S.** Adolescent suicide and suicide attempts: a population study. Pediatr Emerg Care. 1988;4:32-40. [PMID: 3362732]
94. **Sacks JJ, Mercy JA, Ryan GW, Parrish RG.** Guns in the home, homicide, and suicide [Letter]. JAMA. 1994;272:847-8. [PMID: 8078158]
95. **Litaker D.** Guns and homicide in the home [Letter]. N Engl J Med. 1994; 330:365-6. [PMID: 8277960]
96. **Kleck G.** Suicide in the home in relation to gun ownership [Letter]. N Engl J Med. 1992;327:1878. [PMID: 1308120]
97. **Kellermann AL.** Guns and homicide in the home [Letter]. N Engl J Med. 1998;339:928-9. [PMID: 9750102]