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Firearm possession and violent death: A critical review

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Center for Research in Economics, Management and the Arts

Firearm possession and violent death: A critical review

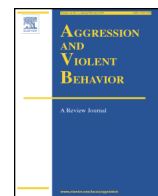
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Aggression and Violent Behavior



Firearm possession and violent death: A critical review

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ABSTRACT

This article critically reviews the empirical research on the association of firearm possession with suicide and homicide. Both suicide and homicide reflect intentional behavior with the goal of killing oneself or another person. Firearms provide merely a means of reaching this goal. The possession of a firearm can, therefore, not be a primary cause of either suicide or homicide. However, since a defining characteristic of both suicide and homicide is the success of killing, and since guns are more effective means for reaching this goal than poison or other weapons, the rate of firearm possession can be expected to be positively related to overall rates of suicide and homicide. This prediction has been tested with individual-level as well as macro-level studies. Individual-level studies, which typically use case-control designs, allow a better control than macro-level studies of the cultural, demographic, and economic determinants of suicide and homicide. In macro-level studies, the potential impact of gun possession on overall rates is likely to be confounded by the factors that motivate people to commit suicide or homicide. Despite these methodological limitations, the research reviewed in this article supports the assumption that easy access to firearms increases the risk of dying from violent causes. With very few exception, studies found gun ownership positively related to gun-related suicides and homicides. Furthermore, there is evidence that guns do not merely serve as substitutes for other means of killing, but increase the overall rates of suicide and homicide.

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1. Introduction

1.1. Firearm possession and violent death: a critical review

It is widely believed that possession of firearms is associated with the rate of gun-related suicides and homicides in the USA as well as worldwide. With 88.8 guns per 100 residents, the USA ranks number one in the world with regard to per capita gun possession (Smallarms Survey, 2007; www.smallarmssurvey.org), before Yemen (54.8), which is number two. Surprisingly, number 3 and 4 are Switzerland (45.7) and Finland (45.3), whereas countries like Lybia (15.5), Mexico (15) or Brazil (8) have much lower rankings. According to a recent Gallup poll, 47% of American adults currently report having a gun in their households, which is the highest rate since 1993, and reflects an increase of 6% since last year (Gallup Organization, 2012). Forty six percent of gun owners report that protection is the primary reason for ownership (Cook & Ludwig, 1996).

Although there has been a substantial decrease in homicide rates since 1990, with a rate of 5.1 homicides per 100,000 people, and more than half of those committed with firearms, the USA still has a fairly high homicide rate for a Western industrialized country (GunPolicy.Org, 2013). In contrast, the overall rate of suicides is comparatively low (12.3 cases per 100,000), but a high proportion of these suicides is committed with a gun (GunPolicy.Org, 2013). It is, therefore, plausible to attribute these high rates of gun-related deaths to the high prevalence of gun ownership in the United States.

2. The role of intention in suicide and homicide

Suicide and homicide are defined as *intentional behaviors* enacted with the goal of killing oneself or another person. According to the CDC (2012a); CDC (2012b), suicide is “death caused by self-directed injurious behavior with any intent to die as a result of the behavior”. Similarly, the FBI (2010) defines criminal homicide as the “willful (non-negligent) killing of one human being” (FBI, 2010). Guns are *instruments or means* to reach this goal. Gun possession is, therefore, a *necessary* but not a *sufficient* cause for gun-related suicides and homicides. Individuals first need to have the goal of killing and second have access to a gun in order to achieve this goal by use of a firearm. Alternatively, they could use poison other weapons to kill.

Since both suicide and homicide require the *intention* to kill, guns are unlikely to be the primary cause of such acts. People are unlikely to commit murder or suicide in order to try out their new gun. However, it is important to note that the possession of firearms is likely to be an important *contributing* factor. Both suicide and homicide are defined by the *success* of injurious behavior. Use of a gun considerably increases the likelihood of reaching the goal of killing oneself or another person: People who use guns to commit suicide are over 250 times more likely to die than those who overdose (Sachs, 2007). And gun assaults are seven times as likely to kill as all other assaults (Zimring, 2004). As Zimring (2004, p. 34) notes: “Guns are only used in 4% of crimes, and only in 20% of all violent crimes, but in about 70% of criminal killings.”

There are two explanations for this: the lethality of weapon or the lethality of intent hypothesis. According to the lethality of weapon interpretation (also known as the *weapon instrumentality effect*), the use of gun increases the likelihood of killing because guns are more lethal than other weapons (e.g., knives). According to the lethality of intention interpretation, gun suicides or attacks are more lethal because people who use guns have a more destructive goal than people who use other weapons.

2.1. Deliberate vs. impulsive behavior

Psychological theories distinguish between intentional behavior that is the result of deliberation and impulsive behavior that reflects spur of the moment actions. According to dual system theories, such

as the Reflective–Impulsive Model of Strack and Deutsch (2004), behavior is determined by two interacting systems that follow different operating principles: the reflective system and the impulsive system. In the reflective system, behavior is the result of reasoning that considers the probability and valences of the consequences of a behavior and results in decisions about the desirability and feasibility of a given action. In contrast, impulses are automatically triggered in the impulsive system by perceptual stimuli that activate associative clusters in long-term memory. The model assumes that the impulsive system is always operating and that the reflective system controls the impulsive system. However, exerting this control requires motivational and cognitive resources. When strong emotions, alcohol consumption, or cognitive load impair the individual's ability to engage the reflective system, behavior becomes largely determined by the impulsive system.

Both suicides and homicides can vary in the extent to which they are premeditated. With regard to suicide, there is evidence that one third to four fifths of suicide attempts are impulsive. Among people who made near lethal suicide attempts, 24% took less than 5 min between the decision to kill themselves and the actual attempt and 70% took less than 1 h (Miller & Hemenway, 2008). Many suicidal crises are temporary. Most people, who attempt suicide never repeat it (Sachs, 2007). More than 90% of people who survive a suicide attempt do not go on to die by suicide (Miller & Hemenway, 2008). It is, therefore, important that suicide attempts by guns are usually successful, whereas attempts by other means (e.g., drugs, cutting) are much less so (Sachs, 2007).

With regard to homicide, the degree of premeditation determines the legal culpability of the perpetrator. This distinction is reflected in legal statutes that divide criminal homicides into two categories, murder and manslaughter. Murder is further divided into first degree and second degree murder. First degree murder is homicide that is well-planned and involves premeditated intent. Second degree murder still involves the intention to kill, but is usually not premeditated. Thus, if a marital quarrel escalates and—perhaps under alcohol influence—one of the partners pulls a gun and kills the other, it will either be categorized as murder in the second degree or voluntary manslaughter.

Voluntary manslaughter is often called a “heat of passion” crime and occurs when a person is provoked (in circumstances which are likely to provoke many reasonable people) and kills in the heat of passion aroused by that provocation. Thus, voluntary manslaughter differs from second degree murder in the severity of the mitigating circumstances surrounding the crime. If the marital quarrel is due to the fact that the wife found her husband in bed with her best friend rather than a fight over misspent money, a homicide might be mitigated to voluntary manslaughter rather than second degree murder. “Killers who act in the heat of passion may kill intentionally, but the emotional context prevents them from having the ability to fully control their behavior. As a result, the heat of passion reduces their moral blameworthiness” <http://www.nolo.com/legal-encyclopedia/homicide-murder-manslaughter-32637-2.html>. In terms of the dual system theory, one could argue that the behavior was largely under the control of the impulsive system, because the reflective system was impaired due to strong emotion.

In contrast, involuntary manslaughter involves an unintentional killing due to criminal negligence. For example, if a drunk driver kills a pedestrian, it would be considered manslaughter. The driver had no intention of killing anybody when he drove his car under the influence of alcohol. However, doing so was negligent, because the driver could have foreseen that his behavior could endanger the lives of others.

The distinction between degrees of homicide that range from premeditated, intentional killing in the case of first degree murder through “heat of passion” killing in the case of voluntary manslaughter to accidental killing in the case of involuntary manslaughter, is highly relevant to the discussion of the availability of guns as a risk factor. It seems plausible that in a premeditated killing (i.e., first degree murder), guns are chosen with the destructive goal of killing the prospective victim. In this situation, the homicide would not be prevented by the absence of a gun, because “the offender would select some other weapon to achieve

the same destructive goal” (Wolfgang, 1958, p. 83). However, in homicides that are not premeditated, such as second degree murder or voluntary manslaughter, the outcome might have been less deadly, if a gun had not been available at that particular moment. The offender might have been so drunk and angry that in “the heat of the moment” he wanted to kill the victim, but if he had not had a gun available, he probably would not have succeeded in doing so. Finally, in involuntary manslaughters (accidental killings) that involves a gun, the availability of the gun is crucial. For example, the five-year-old boy in Kentucky who accidentally shot his little sister would not have done so, had he not been playing with a gun, he had been given for his birthday http://www.standardmedia.co.ke/?articleID=2000082712&story_title=Kenya-5-year-old-boy-shoots-kills-little-sister.

3. Methodological comments

In reviewing studies that relate gun possession to suicide or homicide rates, it is useful to distinguish between *individual-level* and *macro-level* studies. Most of the studies of both types are cross-sectional and, therefore, do not allow causal inferences. However, information from the limited number of longitudinal studies does allow us to argue that certain causal interpretations are more consistent with the evidence than others.

Individual-level studies relate possession of a personal or a household gun to the frequency of suicide or homicide of the owner of the firearm or of persons living in that household. The most frequently used designs for individual-level studies have been case-control designs, where victims of suicide or homicide are compared with matched controls (either still living or dead from nonviolent causes) with regard to frequency of gun ownership. Controls are typically matched to cases with regard to all variables deemed relevant (e.g., age, gender, socioeconomic status). With careful matching, one hopes to achieve equivalence of the two groups, but one can never be certain to have been successful. There is always the possibility of third variable interpretations, namely that some uncontrolled variable is responsible for the difference in outcomes.

Information on gun possession is either based on interviews of family and friends, or on information about handgun purchases or gun licenses. A study of the validity of self-reported data on the presence of guns in the home, in which members of households where a hunting license had been purchased or a handgun registered were interviewed, suggested that 11.4% of the responses were invalid (Rafferty, Thrush, Smith, & McGee, 1995). However, such reporting errors would only be problematic if they resulted in systematic bias (e.g., if underreporting occurred more frequently among controls than cases). Results of case-control studies are reported as odds ratios (OR), reflecting the increased risk of dying from suicide or homicide in homes where guns are available compared to homes where guns are not available. Odds ratios are reported for gun-related suicides/homicides or suicides/homicides by any means. If access to guns resulted merely in a *substitution* of guns for other weapons, gun-availability would only increase the odds for gun-related deaths, but not for the overall suicide/homicide frequency.

Macro-level studies relate the rate of household gun ownership at the international or national level to suicide or homicide rates at the same level. The association is typically reported as correlations between these rates across different counties, states or countries. For example, national studies conducted in the USA assess the association between the rates of gun possession in different States and the rates of suicide or homicide. Since there are no reporting requirements for firearm sales or ownership in most states in the USA, gun ownership rates have been generally estimated through surveys. One such survey is the *General Social Survey (GSS)* conducted by the University of Chicago. Another survey is the *Behavioral Risk Factor Surveillance System (BRFSS)*, an ongoing data collection program in 50 states of the USA sponsored by the Centers for Disease Control and Prevention (CDC). Whereas the GSS is conducted face-to-face, the BRFSS is a telephone survey. The *Gallup Organization*, (2012) has also conducted telephone

surveys for many decades that included questions on gun ownership. These data are likely to be affected by underreporting (Rafferty et al., 1995). As long as underreporting does not introduce systematic errors it would be unproblematic. However, if one assumes that descriptive norms regarding gun possession are correlated with actual rates of gun possession in different US States (or different countries), more underreporting could occur in states or countries with low rates of gun possession.

Researchers have sometimes used indirect measures for gun ownership. The best known is the *Cook's Index* (Cook, 1979) based on the average of the percent homicides involving a gun and the percent suicides involving a gun. A study that compared several indirect measures to survey estimates of gun ownership found that the percent suicides committed with guns produced the most consistent results (Kleck, 2004). However, because this study was conducted in the USA, it cannot necessarily be assumed that the percentage of gun-related suicides is as good a measure of gun possession in other countries (e.g., Adjacic-Gross et al., 2010).

Suicide or homicide rates reflect the annual frequency of suicides or homicide adjusted for population size. They are either reported as overall or as gun-related homicide rate per 100,000. These rates are likely to be influenced by the cultural, economic, and demographic factors that affect people's motivation to commit suicide (e.g., Durkheim, 1887/2002; Neymayer, 2003; Reeves et al., 2012; Stuckler, Basu, Suhrcke, Coutts, & McKee, 2009) or murder (e.g., Land, McCall, & Cohen, 1990; Fajnzylber, Lederman & Loarza, 2002; McCall, Land, & Parker, 2010; Stolzenberg, Eitle, & Alessio, 2006; Tcherni, 2001). This is particularly problematic for international comparisons, where a wide variation in these factors can be expected, but to a lesser extent also for national studies conducted in the USA. There are cultural and economic differences between states, such as Wyoming, Arkansas or Alabama, that have more than 50% gun owners and states with less than 30% gun ownership such as Delaware, New York, or Massachusetts. Unless macro-level studies control for these factors overall rates should be a poor indicator of the effects of gun possession. Another problem for international studies is the variation in the relative importance of factors across different countries. For example, as Killias and Markwalder (2013) suggest, in Finland murder seems to be mainly related to alcohol abuse among generally violent people whereas most murders in the Netherlands take place in a criminal context.

To create a “purer” measure of the influence of firearm availability on homicide/suicide rates, one can use the proportion of homicides/suicides that were committed with firearms. This proportion should most strongly reflect the facilitative influence of gun ownership. For example, there are 5.1 homicides per 100,000 people in the USA and 0.7 in Switzerland (GunPolicy.Org, 2013), even though Switzerland is number 3 in the world with regard to rate of gun ownership. At 0.52, the rate of gun-related homicides is, therefore, much lower in Switzerland than in the USA where the rate is 3.6. However, if we look at the proportion of homicides that were committed with guns in both countries, we realize that at nearly two thirds, these proportions are quite similar. The major shortcoming of this proportion is that it does not tell us whether guns merely serve as a *substitute* means of killing, or whether easy access to guns actually *increases* the absolute number of suicides or homicides.¹ Obviously,

¹ It is important to note that a positive correlation between gun availability and overall suicide or homicide rates does not necessarily imply that high availability of guns results in an increase in suicides or homicides. A perfect correlation between these two measures could also indicate complete substitution of non-firearm suicides/homicides with firearm-related suicides/homicides. If people with access to firearms would use them for committing murders or suicides for which they would have used other weapons, if guns had not been available, the correlations between firearm possession and overall rates should be high. However, in that case, firearm availability should be negatively related to rates of non-firearm suicides/homicides. Only if this correlation is not significant, can a positive correlation between gun availability and overall rates of suicide or homicides be interpreted in terms of guns increasing the risk of deaths.

Table 1
Increased risk of suicide for gun owners vs. non owners (case control studies).

Authors	Time of study and measure	Location	N of suicide cases	N of controls	OR overall suicide	OR gun-related suicide
Kellermann et al. (1992)	1987–1990 Household gun possession	3 counties in Washington, State;	438	438 (alive)	4.8	–
Wiebe (2003)	1993 Household gun possession	US National	1959	13,535 (alive)	3.44	16.89
Dahlberg et al. (2004)	1993 Household gun possession	US National	1049	535 (non violent deaths)	5.6	31.1
Grassel et al. (2003)	1996–98 Handgun purchases 1998 Suicide	California	3214	208,738 (non violent deaths)	6.8	12.5
Cummings et al. (1997)	1980–1992 Handgun purchases	Washington State	353	1756	1.9	3.1
Wintemute et al. (1999)	1991 Handgun purchases	California	3722	General population	4.31 (1st year)	7.12 (1st year)
	1991–1996 Mortality		(1st year)		(all 6 years)	3.50 (6 years)
Klieve, Svetcic, & De Leo (2009)	1997–2004 Gun license	Queensland, Australia	4469	Queensland population	2.09	10.92

gun availability would be more dangerous if it induced suicides/homicides that would not have been committed if guns had not been accessible.

4. Review of empirical studies

This review focuses on empirical studies of the relationship between gun ownership and suicide or homicide conducted since 1990. It focuses on more recent studies, not only because the earlier research has been reviewed (e.g., Hepburn & Hemenway, 2004), but also because more recent research uses more sophisticated designs and is based on larger sample sizes. A systematic literature search was conducted entering the key words gun ownership/gun possession and suicide/homicide into the search programs Scopus, PsycInfo and PubMed. Reference lists of relevant articles were also examined. The aim was to include all individual- and macro-level studies that related gun ownership or gun possession to suicide or (criminal) homicide published since 1990. Studies that involved the effects of gun control measures were excluded. Most of the studies included in this review have been conducted in the United States, but there was also some European research.

4.1. Suicide

The scientific literature on the factors that motivate people to take their own life is still strongly influenced by Durkheim's (1887/2002) classic study of suicide, in which he argued that explanations of suicide had to be mainly social. For Durkheim, the major determinants of suicide rates were the extent to which individuals were integrated into a social group as well as regulated by the norms and conventions of that group. Consistent with Durkheim's ideas, there is evidence that higher divorce rates, absence of children, higher female labor force participation, and higher ethno-linguistic heterogeneity are associated with increased rates of suicide (Neymayer, 2003). Economic crises are also factors likely to increase suicide risk. Suicide rates increase during economic crises (e.g., Reeves et al., 2012) and particularly increases in rates of unemployment are associated with increased suicide rates (e.g., Stuckler et al., 2009). Other important risk factors for suicide are depression and alcohol problems (Balon, 1987; Miret, Ayuso-Mateos, Sanchez-Moreno, & Vieta, 2013). Unless researchers control for these risk factors, they run the risk that the effect of gun possession on suicide rates will be swamped by these other effects.

4.1.1. Predictions

If gun ownership facilitates suicide, there should be a positive association between gun ownership and suicide rates. If gun ownership actually increases suicide risk rather than merely serving as a substitute for other means of suicide, gun ownership should be associated with an increase in gun-related suicides as well as overall suicides. Since most of the studies use cross sectional comparisons, a positive association

could be partly or fully due to reverse causation, namely that people, who want to commit suicide go out to buy guns.

4.1.2. Individual-level studies

One of the earliest case-control studies was conducted by Kellermann et al., (1992; Table 1). Only suicides committed at the home of the victim were studied. Information about the availability of firearms was obtained from the police or from friends or relatives of the deceased. Control subjects were matched according to sex, race, age range and neighborhood of residence. Controlling for significant covariates, such as the consumption of alcoholic beverages, previous hospitalization due to drinking, prescription of psychotropic medicine for depression or mental illness, use of illicit drugs, and non-graduation from high school, gun availability at home was associated with a nearly fivefold increase in suicide in case subjects over controls. In homes with firearms, a gun was chosen as method for suicide in 86% of cases. In homes with no firearms, only 6% of suicides were committed with a gun.

Similar results were reported from a national case-control study by Wiebe (2003). The case subjects were drawn from the 1993 National Mortality Followback Survey a nationally representative survey (CDC, 1993). Information about gun possession was based on interviews with relatives or friends. Ten living control subjects for each case were drawn from the 1994 National Health Interview Survey (CDC, 1994), which contained information about gun possession. They were matched by sex, race, and age group. Having a firearm at home increased the (overall) risk of suicide more than threefold and most of these suicides were committed by firearms. Household gun possession was inversely related to committing suicide with another method, suggesting some degree of substitution.

In another national case-control study, Dahlberg, Ikeda, and Kresnow (2004) also identified suicide victims from the 1993 National Mortality Followback Survey. Death certificates were used to identify the cause of death and only suicides committed at home were included as cases. The availability of firearms in the home was established through interviews with relatives or friends of the deceased. Gun possession among these individuals was compared to that of deceased who had died at home from non-violent causes. Gun availability was associated with a significant increase in suicide rates overall as well as gun-related suicides. Persons with guns in the home were at significantly greater risk dying from suicide at home (relative to other causes of death), with the association being stronger for men than for women.

Another case-control study compared gun possession of individuals who died from suicide in 1998 in California with that of individuals who died from natural causes. In this study, information about handgun purchases was used as indicator of gun possession (Grassel, Wintemute, Wright & Romero, 2003). Gun purchase was associated with a significantly increased suicide rate. Although these effects were strongest during the first year of handgun purchase, they were significant for the whole three-year period. Over the period of three years, suicide victims were nearly seven times more likely to have purchased a firearm than

Table 2

Macro-level studies of the relationship between gun possession and suicide.

Authors	Locations	Time	Overall rates	Gun-related rates
Killias (1993)	18 developed countries	1989–1992	ns	Rho = .92
Killias et al. (2001)	21 developed countries	1990–1995	ns	Rho = .79
Konty & Schaefer (2012)	168 nations from Africa, Asia, Europe, North America, South America, Oceania	2007 (firearm possession) 2002 (mortality)	Rho = .19; Not significant with control variables introduced	–
Adjacic-Gross et al. (2006)	13 countries	1983–2000	–	Changes in gun ownership related to changes in proportion of gun suicides
Kaplan and Geling (1998)	50 US States	1989–1991	–	Rho = .96 (white males) to rho = .64 (black females)
Miller, Azrael, & Hemenway, 2002	50 US States	1989–1997	OR High vs. low gun States 1.6	OR High vs. low gun States 3.8
Miller et al. (2004)	7 Northeastern US States	1996–2000	r = 0.97	r = 0.97
Miller, Lippman et al. (2007)	50 US States	2000–2002	OR High vs. low gun States 1.9	OR High vs. low gun States 3.8
Kposowa (2013)	20 US States with highest suicide rates	Gun possession: 2000 Suicide: 2001–2004	OR = 1.042	–
Etzersdorfer et al. (2006)	Austria	1990–2000	Rho = 0.38	Rho = 0.967
Adjacic-Gross et al. (2010)	Switzerland	1998–2007	–	Rho = .53 (men) Rho = .50 (women)

individuals dying from natural causes and this difference was mainly due to fire-arm related suicides.

A case-control study based on members of a large health maintenance organization in Seattle, which operationalized gun possession as purchase of a handgun reported the same pattern (Cummings, Koepsell, Grossman, Savarino, & Thompson, 1997). Control participants were selected from individuals, who were members of the health maintenance organization on the day the case subject died, and matched with regard to sex, age, and area of residence. Individuals living in a house with a handgun had nearly twice the risk of committing suicide compared to individuals without a handgun in the house and an even more than three times increased risk of suicide involving a gun. The relative risk for suicide was somewhat greater during the first year after purchase, but remained increased even after five years.

A population-based cohort study compared the suicide mortality of individuals who purchased a handgun in California in 1991 from a legal dealer with that of the general population of the state (Wintemute, Parham, Beaumont, Wright & Drake, 1999). In the week after the purchase, their suicide rate was 57 times higher than that of the general population. This increased risk of suicide continued during the first year after the purchase when their suicide rate was still more than four times higher than that of the general population an excess that was totally attributable to gun-related suicides. Their excess risk was maintained at a reduced level throughout the six-year study period. Although the findings of this study are interesting, the comparison of cases with the general population is problematic, particularly if authors are unable to control for socio-demographic characteristics.

Finally, a study conducted in Queensland (Australia) related the suicide rate to the gun license history of individuals accessed from the firearm registry (Klieve, Svetic, & De Leo, 2009). Again, individuals with a license history had a far higher rate of suicide by any means as well as gun-related suicides than individuals without a license.

4.1.3. Macro-level studies

4.1.3.1. International comparisons. Killias (1993) conducted one of the first large-scale international studies of the association between household gun ownership and suicide (Table 2). The measure of household gun possession came from the International Crime Survey (Del Frate, Zvekic, & van Dijk, 1993), a telephone survey in which respondents were asked whether they kept any firearm in their household. International suicide data are provided by the World Health Organization (WHO). Killias (1993) found a significant correlation between firearm

ownership and gun-related suicides (but not overall suicide rates) in 18 developed countries. Gun-related suicide rates were highly correlated with gun ownership rates. This high correlation is surprising, given that there were no controls for economic, demographic or cultural differences which might have influenced overall rates. In 1996, this survey was extended to additional countries and Killias, van Kesteren, and Rindlisbacher (2001) used these data to include 21 countries in their study. They found, again, a high correlation between suicide with gun and gun ownership. As in the earlier study, the overall suicide rates were not associated with gun ownership.

Another international study also found a small but significant bivariate positive relationship between gun ownership and overall suicide rates for countries from Africa, Asia, Europe, North America, South America, and Oceania (Konty & Schaefer, 2012). However, this relationship was reduced to zero when control variables, such as age structure of the society and Gross National Product (GDP), were introduced. There were fewer suicides in societies with a great proportion of young people and a higher GDP. Gun ownership estimates were based on the 2007 Small Arms Survey (www.smallarmssurvey.org). Suicide rates were based on WHO mortality estimates for 2002. Given that gun possession rates vary over years, it is not unproblematic that the suicide rates are for an earlier period than the estimates of gun possession.

One international longitudinal study related changes in the proportion of firearm suicides to changes in the percentage of firearm suicide for 13 highly developed countries (USA, Switzerland, Finland, France, Canada, Sweden, Australia, the Netherlands, England and Wales, Scotland, Norway, Spain, and New Zealand) for the years 1983 to 2000 (Adjacic-Gross et al., 2006). This study is particularly interesting, because the proportion of households owning firearms and the proportion of firearm suicides within overall suicides varied considerably across countries and also over time within countries. The analysis via random coefficient models confirmed that the significant effect on the proportion of firearm suicides derived from the variation in the proportion of households owning firearms.

4.1.3.2. National comparisons. The association between rate of gun ownership and gun-related suicides was replicated in a study of state-level household firearm ownership and rates of suicide across 50 States of the USA by Kaplan and Geling (1998), who used data from the GSS as indication of state-level gun ownership rates and suicide mortality data from the CDC. Kaplan and Geling reported high correlations between gun ownership and the rate of gun-related suicides. Although no information is given on the relationship between gun availability

and overall suicide rates, the fact that the relationship was not significant for non-firearm suicides makes substitution unlikely.

Miller, Hemenway, and Azrael (2004) related firearm prevalence in seven Northeastern states to suicide rates. Firearm prevalence was highly correlated with both firearm suicide rates and overall suicide rates. The authors also collected data on suicide attempts. The relationship between the prevalence of firearms and suicide remained strong when suicide attempts were controlled for in a regression. This indicates that the firearm suicide connection is not due to a greater suicidal tendency among inhabitants in areas with more guns.

Comparable associations between suicide rates and firearm availability were reported in two studies based on data for all 50 States (Miller, Azrael & Hemenway, 2002; Miller, Lippmann et al., 2007). Again higher rates of gun ownership were associated with higher gun-related and overall suicide rates. A comparison of States with high and low levels of firearm ownership found firearm-suicide rates nearly four times as high in States with high ownership levels. These States had also substantially higher overall suicide rates. Whereas the 2002 study reported some evidence for substitution (i.e., lower rates of non-firearm suicides in low-gun States) there was no evidence for substitution in the 2007 study. The association between household firearm ownership and non-firearm suicides was not significant.

A study relating suicide rates for the years 2000 to 2004 to gun ownership in the 20 US States with the highest suicide rate reported a positive association between these two variables (Kposowa, in press). Suicide data were derived from the national US Multiple Cause of Death File. Firearm availability was measured as the percentage of households in each state that kept firearms at home, based on data obtained from the BRFSS 2001. The association between gun ownership and suicide rates was relatively weak in this study, which could have been due to the fact that state suicide rates were also included as a (predictor) variable. Since state suicide rate will to some extent be influenced by the availability of firearms, inclusion of this variable as additional might have weakened the association between gun ownership and suicide rates in this study.

A study conducted in Austria related the frequency of gun licenses in the nine Austrian counties to suicide rates (Etzersdorfer, Kapusta, & Sonneck, 2006). They found a high positive correlation between gun licenses and firearm-related suicides. The relationship with overall suicides was considerably lower.

Finally, a study conducted in Switzerland compared the proportion of suicides committed with a gun in Cantons with high versus those with relatively low proportion of gun-owning households (Adjacic-Gross et al., 2010). For men, 32.6% of all suicides were committed by guns, whereas for women, the percentage was only 3.4%. And yet, the percentage of fire-arm suicides correlated significantly for both genders with a rank order of cantons according to the proportion of houses that had firearms. The association of gun ownership with overall suicide rates is not reported.

5. Discussion

The studies on gun ownership and suicide provide strong evidence that these two variables are associated (Tables 1 and 2). All seven case-control studies found gun ownership significantly associated with substantial increases in overall suicide rates. The six studies that also reported on gun-related suicides found even more substantial increases. The picture is somewhat more mixed for macro-level studies, particularly those relying on international comparisons. Thus, even though the studies by Killias (1993) and Killias et al. (2001) reported high correlations between gun ownership rates and gun-related suicides, the relationship with overall rates was not significant. This might indicate a high degree of substitution, but could also be due to their failure to control for economic, demographic, or cultural differences between countries that are known to influence overall rates. In their longitudinal study of 13 countries, Adjacic-Gross et al. (2006) even observed a relationship between changes in gun ownership over the years of the study to changes in the proportion

of gun suicides. The weakest association for overall suicide rates was reported by Konty and Schaefer (2012) in a study involving 168 nations. However, this study is problematic; the mortality data were for the year 2002, and the firearm possession data from 2007. It is quite possible that both rates might have changed during this five-year period. The findings of seven national studies of which five were conducted in the USA and two in Switzerland and Austria, are supportive of an association between gun possession and suicide rates.

Given the cross-sectional designs of most of the studies reported in this section, the association of gun availability with suicides committed with a gun is also consistent with the assumption that people bought guns to commit suicide rather than used guns, because they were available. The evidence from the longitudinal information provided by the studies of Wintemute, Parham, Beaumont, Wright, and Drake (1999) and Cummings et al. (1997), that the risk of suicide is higher in the first week or even the first year after the gun purchase, suggests that this reverse causality assumption explains part of the association between gun ownership and suicide. Some people seem to indeed buy guns with the intention to commit suicide. However, both studies, as well as the investigation by Grassel, Wintemute, Wright, and Romero (2003), found that the suicide risk remained increased for many years after the gun purchase. This supports the assumption that the availability of a gun increases the risk of suicide.

Since guns are only a *means* to use for a purpose, it would be possible that gun suicides were simply substituted for other forms of suicide. If this were the case, gun-ownership should not have been associated with an overall increase in the risk of suicide in case control studies. Furthermore, since case-control studies matched participants with regard to age, gender, and economic circumstances, it is difficult to think of an alternative explanation for the fact that all of these studies found gun possession associated with a significant increase in overall suicide. Given that one third to four fifth of suicide attempts are impulsive (Miller & Hemenway, 2008) and that suicide attempts involving a gun are much more likely to be successful than suicide by other means, it is also very plausible that easy access to firearms should increase the risk of suicide.

5.1. Homicide

An excellent review of earlier studies of the association between gun availability and homicide has been published by Hepburn and Hemenway (2004), which concluded that “the available evidence is consistent with the hypothesis that increased gun prevalence increases the homicide rate” (p. 417). The present review will focus on research published since 1990. Although there will be some overlap with the earlier review, this examination will cover a great number of more recent studies that typically have larger sample sizes and more controlled designs than earlier studies.

It is interesting to note that the criminological literature on determinants of homicide does not consider gun possession as a factor. The major determinants discussed in that literature are resource deprivation, racial heterogeneity, social disintegration, and the percentage of young people in a population (e.g., Land et al., 1990; Fajnzylber et al., 2002; McCall et al., 2010; Stolzenberg et al., 2006; Tcherni, 2001). Since overall homicide rates will be strongly influenced by these factors, any impact of variation in gun possession will be difficult to detect in macro-level studies. This will be particularly problematic for international studies. Controlling for these factors will be difficult, because relevant information will not always be reliable. Furthermore, the fact that criminologists appear to be unable to explain the unexpected and substantial decrease in homicides and other major crimes in the USA since 1990 (e.g., Barker, 2010; Zimring, 2007) suggests that there is still considerable uncertainty about the relative importance of these determinants.

5.1.1. Predictions

Although there are only three possible empirical outcomes of the studies reported in this section, namely a positive, a negative, and no

Table 3
Increased risk of homicide for gun owners vs. non owners (case control studies).

Authors	Time of study and measure	Location	N of homicide cases	N of controls	OR overall homicide	OR gun-related homicide
Kellermann et al. (1992)	1987–1900 Household gun possession	3 counties	388	388 (alive)	2.7	–
Wiebe (2003)	1993 Household gun possession	US National	1720	8,084 (alive)	1.41	1.72
Dahlberg et al. (2004)	1993 Household gun possession	US National	490	535 (non violent deaths)	1.9	16.4 (persons living with others aged 35 and older)
Grassel et al. (2003)	1996–98 Handgun purchases: 1998 Suicides	California	1657	208,738 (non violent deaths)	2.4	3.3
Cummings et al. (1997)	1980–1992 Handgun purchases	Washington State	117	582	2.2	2.2
Wintemute et al. (1999)	1991 Handgun purchases 1991–1996 Mortality	California	Not reported	General population	–	0.84 (men) 2.20 (women)
Kleck and Hogan (1999)	1980–1991	US National	1095	Random sample of general population	1.36	

relationship between the availability of guns and the occurrence of violent crime, there are several different explanations for each of these empirical associations. For example, researchers have offered three explanations for a positive relationship between gun possession and homicide. The weapons instrumentality hypothesis assumes that a positive relationship would be due to the greater lethality of guns, namely that guns provide the most effective means of killing other people. People, who live in environments where guns are easily available, are more likely to be murdered, because the potential murderers are likely to have a gun and are thus more likely to kill a potential victim in an attack. This is the widely held “More guns more crime” position.

A slightly different interpretation has been offered by Kleck and McElrath (1991) who argued that the relationship between gun prevalence and murder could be due to the fact that people, who have the intention to kill another person, are more likely to use a gun than other means. Thus, part of the difference in deaths attributed to weapon type is due to the more lethal intent of individuals who use a gun. Because people with a lethal intent are likely to use other weapons if guns are not available (Wolfgang, 1958), gun availability should be negatively associated with homicides that do not involve firearms (i.e., substitution). Finally, the positive relationship between gun prevalence and homicide rates could be to reverse causation, namely high homicide rate encouraging people to buy guns for self-defense.

There are two possible explanations for the *negative* association between gun prevalence and violence. In gun-rich environments, the potential victim is also likely to own a gun. And since guns are assumed to provide an effective means of *defending* oneself against violent assaults, one could also predict that people who own guns should be less likely to be killed. In this case, a crime has been committed in so far as an individual has been attacked, even if the attack proved not to be successful. Alternatively, the deterrence hypothesis would argue that the knowledge that everybody owns a gun might deter criminals from planning any crimes.

Finally, there are two possible explanations for the failure to find a relationship between gun prevalence and homicide, namely that there is no relationship between these two variables or that two opposing processes cancelled each other out.

5.1.2. Individual-level studies

A case–control study by Kellermann et al. (1993) focused exclusively on homicides that occurred in the home of the victims (residents of counties in Tennessee, Washington and Ohio) over a 5-year period (Table 3). During this period, 444 such homicides occurred of which 388 could be matched to controls. Individuals living in a home with a firearm were nearly three times as likely to be murdered as individuals living a home where no gun was kept. Most victims were killed by a relative or friend. Only very few were killed by a stranger. A majority of homicides was committed in the context of a quarrel. However, only half of these homicides were committed with a gun. Case subjects

more commonly consumed alcohol and previous periods of violence were also reported more frequently by members of case households.

Most of the other studies related gun ownership to suicide as well as homicide. Their design has, therefore, already been described in the section on suicide. The case–control study of homicide victims conducted by Wiebe (2003) replicated the findings of Kellermann et al. (1993). Compared to adults in homes with no guns, individuals living in a home with a gun had a significantly increased risk of being murdered. This increase in homicide risk was entirely due to gun-related homicides. Wiebe also found that more than 50% of the victims knew their killer, and 15.5% of homicides occurred during a family argument.

In another case–control study, Dahlberg et al. (2004) reported that persons with a gun in the home were at a higher risk of dying from a homicide at home. Thus gun availability was associated with significantly increased homicide rates. Most homicide victims knew their assailant. However, whether a homicide was committed with a gun or by other means, depended on whether a person lived alone. The risk of a gun-related homicide (rather than a homicide by other means) was only increased for individuals living with others. For those living alone at home, there was no association between the presence of a firearm at home and the method of homicide. This suggests that the deaths of individuals living with others may have been related to domestic violence or other interpersonal disputes.

The case–control study of Grassel et al. (2003) compared homicide victims to individuals in the California population, who had died from natural causes during the same period. Although there were 1657 homicide victims, only 32 had recently bought a handgun. Despite this small number, handgun purchasers had a significantly higher risk of being murdered than people, who had not bought a handgun and this difference was particularly marked for gun homicides. However, as mentioned earlier, using the general population as control group is problematic, since it makes matching on important control factors more difficult.

The case–control study conducted among members of a large health maintenance organization by Cummings et al. (1997) also compared gun ownership of homicide victims to matched control subjects. The risk of homicide for individuals with a family handgun was twice as high as that of individuals with no handgun in the family. The risk of gun-related homicide was similarly increased.

The longitudinal study of Wintemute et al. (1999) found that fewer men, who had recently bought a handgun, were murdered than would be expected on the basis of the population. For women, the murder rate was higher than expected. However, as mentioned in our discussion of the suicide data of this study, a comparison of a relatively small sample with population data is always problematic, but particularly so if one is unable to control for socio-demographic characteristics.

A national case–control study has been conducted by Kleck and Hogan (1999) comparing a nationally representative sample of persons serving sentences in state prisons in 1991 for committing murder to a general sample of US adults interviewed in the GSS between 1984 and

Table 4
Macro-level relationship between rates of gun ownership and homicide.

Authors	Locations	Time	Overall rates	Gun-related rates
Killias (1993)	18 developed countries	1989–1992	ns	Rho = .54
Killias et al. (2001)	21 developed countries	1990–1995	ns	ns
Hemenway and Miller (2000)	26 high income countries	1990–1994	Cook Index $r = .74$ FS/S $r = .69$	–
Hoskins (2001)	36 countries highly and moderately developed countries	1990–1994	$r = .37$	–
Alzheimer and Boswell (2012)	43 nations (Western, East European & Latin America)	2000–2005	Negative relationship	–
Konty and Schaefer (2012)	168 nations from Africa, Asia, Europe, South America, South America, Oceania	2007 (firearm possession) 2002 mortality	Rho = $-.36$ Zero with introduction of control variables	–
Duggan (2001)	US states	1980–1998	Changes in gun ownership positively related to homicide rates	Changes in gun ownership positively related to homicide rates
Price et al. (2004)	50 US States	1999	$r = .516$	–
Miller, Hemenway et al. (2007)	50 US States	2001–2003	Strong positive association	Strong positive association
Kaplan and Geling (1998)	50 US States	1989–1991	–	Rho = .88 (females) to rho = .25 (males)
Moody and Marvell (2005)	50 US States	1977–1998	No relationship	–
Gius (2009)	50 US States	2001, 2002, 2004	Weak positive association	–
Hoskins (2011)	120 US counties	2001–2002	Strong positive association	–
Bridges and Kunselman (2004)	Canada	1974–1999	Cook's Index $r = .80$	Cook's Index $r = .94$
Stolzenberg and D'Alessio (2000)	South Carolina (46 counties)	1991–1994	Positive association for illegal guns; No association for legal guns	–

1988–91. In the inmate sample, only those who had committed an intentional criminal homicide when age 18 or older were included. It was not possible to distinguish between gun homicides and non-gun homicides. In a multivariate analysis that controlled for sex, race, age, marital status, education, and income, the odds of person owning a gun committing murder was 1.36 times as high as the odds among persons not owning a gun.

5.1.3. Macro-level studies

5.1.3.1. International studies. In the large study described earlier, Killias (1993) correlated rate of gun ownership and gun-related homicides in 18 countries (Table 4). The correlation was significant, but lower than that for suicide. Furthermore, the correlation with overall homicide rates was not significant. In the extension to 21 countries, the correlation was no longer significant for homicides involving a gun (Killias et al., 2001). This failure to find a significant correlation could be due to the fact that no control variables were included in these studies.

Another large international study focused solely on high income countries as defined by the World Bank (Hemenway & Miller, 2000). The study included 26 high income countries. They used two indirect measures for gun availability, namely the percentage of suicide in each country that was committed with a firearm and the Cook's Index (1979). There was a high and significant correlation between the total homicide rates and both measures of gun availability. However, when the United States were removed as an outlier, the association remained significant only for the Cook's Index, but not for percentage of firearm-related suicides.

Using the data on proportion of gun-related suicides provided for 36 highly and moderately developed nations by Krug, Powell, and Dahlberg (1998) as indirect measure of household gun ownership, Hoskins (2001) conducted an international study. He related this (indirect) measure of 1990 firearm availability to the average of 1990 to 1994 homicide rates in these 36 countries. The number of countries was sufficiently large to allow him also to include important control variables. One control variable was his "welfare state index" consisting of a combination of the measure of economic inequality (Gini), a measure of services provided by the state that lowered the reliance of poor individuals on the market for sustenance and support, and the Gross National Product of a country. Further variables included were perceived economic

inequality and ethnic heterogeneity. Finally, Hoskins also constructed a dummy variable reflecting East Asian vs. non East Asian countries, because homicide rates and gun ownership rates are known to be low in East Asian countries. Hoskins reported that higher homicide rates were most strongly associated with ethnic heterogeneity and low welfare state index. Firearm availability was also significantly—although less strongly—associated with homicide rates.

There are two international studies that failed to replicate the positive association between homicide and gun possession. One is a study by Alzheimer and Boswell (2012), who related gun availability to homicide for 43 nations over a six-year period and controlled for economic inequality, proportion of young males, and urbanization. Gun availability was negatively related to homicide. Although economic inequality, proportion of young males and urbanization influenced gun homicides, these effects were opposite (e.g., more economic inequality-fewer homicides) to what one would expect from findings of other studies. One problem with this study is the choice of rates of gun-related suicides as indirect measure of gun availability. Whereas the proportion of suicides committed by gun has been shown to be a valid measure of gun availability (at least in the USA), the rate of gun suicides is likely to be less valid, because it is strongly influenced by the total number of suicides in a given country (Kleck, 2004).

Another study with negative results used national level data for 168 nations from the Small Arms Survey (Konty & Schaefer, 2012). The bivariate correlation demonstrated a negative relationship between firearm availability and homicide. However, this association was reduced to zero when control variables such as average well-being (GDP) and absolute poverty (infant mortality) were introduced. These two variables explained nearly half the variance in cross-national homicide rates.

5.1.3.2. National studies. Using subscription rates for one of the largest US gun magazines (*Guns & Ammo*) as a proxy for gun ownership, Duggan (2001) examined the association between changes in gun ownership and changes in violent crime both at the state and the county level. To validate his measure of gun ownership, he demonstrated that state level subscription rates to *Gun & Ammo* were strongly associated with state level estimates of gun ownership based on the GSS. Some years later, Kleck (2004) reported that city level subscription rates to *Gun &*

Ammo were highly correlated with GSS data on percentage households with guns in 45 cities. The homicide data were obtained from the FBI and the NCHS. Duggan (2001) first showed that changes in state level gun ownership are associated with changes in homicide rates. Since this association could also have been due to increases in homicide rates motivating people to buy guns, he further tested whether lagged increases in gun ownership were associated with increased in homicide rates. He found a 10% increase in gun ownership in the current year associated with a 2.14% increase in homicide rate the following year. Furthermore, increases in gun ownership were only associated with increases in gun homicides but not non-gun homicides. The effect of lagged homicide rates on gun ownership was also significant, but much weaker. (A 10% increase in homicide rate is associated with only a 0.2–0.3% increase in gun ownership).

Price, Thompson, and Dake (2004) related firearm data for all US States from the CDC to an estimate of state level firearm ownership based on the proportion of suicides committed by firearm. In bivariate analyses, the percent of state population that was African American ($r = .75$), the violent crime rate other than homicide ($r = .68$), and firearm prevalence ($r = .42$) were positively correlated with firearm homicide deaths. When controlling for these other variables, the relationship with firearm homicide deaths actually became stronger ($r = .516$) with 27% of the variance of firearm homicides from state to state being associated with the prevalence of firearms.

The relationship between firearm prevalence and homicide rates was replicated by Miller, Hemenway, and Azrael (2007), who related firearm prevalence data from the 2001 BRFSS to homicide data aggregated over the years 2001 to 2003. They found that states with higher rates of firearm ownership had significantly higher homicide victimization rates of men, women, and children both overall and gun-related homicides, even controlling for state-level rates of aggravated assault, robbery, unemployment. They estimated that each one-percentage point difference in household firearm ownership was associated with 3.3% difference in homicide victimization. Non-firearm homicides were unrelated to gun ownership. Using CDC data for homicide and GSS data from firearm availability 1989–1991, a similarly strong positive association was reported by Kaplan and Geling (1998) but only for women. For men, the association was not significant. Gius (2009), who used homicide data from the Uniform Crime Reports and gun ownership data from the BRFSS for the years 2001, 2002, and 2004 also found a positive relationship with overall homicide rates, but it was weak and only marginally significant.

Hoskins (2011) related household gun prevalence in 120 US counties for 2001–2002 to homicide rates averaged over the years 2001–2002, controlling for population density, income inequality, unemployment rate, and alcoholism rates. He found a positive and significant association between gun ownership and homicide. Homicide was also significantly positively associated with population density, income inequality, unemployment, and alcoholism. Percent white, percent females, and percent with at least a bachelor degree were negatively associated. Gun ownership was also associated with aggravated assault, but unrelated to robbery rates. Hoskins (2011) argued that the fact that gun prevalence was unrelated to robbery rates was inconsistent with the deterrence notion (i.e., that robbers would be deterred from robbing houses, if they perceived a high risk of being confronted with an owner armed with a gun).

Using the Cook's Index to relate firearms availability to homicide rates in Canada between the years 1974 to 1999, Bridges and Kunselman (2004) found a correlation of 0.94 with homicides committed with firearms and 0.80 with total homicide rates. Since the Cook's Index consists of the average of the proportion of gun suicides and gun homicides, it is perhaps more informative that firearm homicides also correlated 0.91 with the accidental firearm death rate.

There are two studies with discrepant results (Moody & Marvell, 2005; Stolzenberg & D'Alessio, 2000). Using the National Incident-

Based Reporting System (NIBRS) for South Carolina, Stolzenberg and D'Alessio (2000) investigated whether gun availability is related to violent crime. The advantage of the NIBRS is that it allows distinguishing between illegal and legal gun availability. The data for this study were obtained for the years 1991 to 1994 for 46 counties. The number of guns stolen annually in each county was used as indicator of illegal gun availability. Legal gun availability was measured as the annual number of concealed weapon permits issued to citizens of each county. The authors reported significant positive effects of illegal (but not legal) gun availability on violent crimes committed with guns. The effect on violent knife crime rate was not significant, indicating that the stolen gun rate was not merely an indicator of the general level of violence. The fact that the annual number of concealed weapon permits was unrelated to rates of violent crime is inconsistent with the self-defense hypothesis which assumes that legitimate gun availability reduces violent crime. Finally, Moody and Marvell (2005) failed to find any relationship between gun prevalence and murder rates in a study based on state-level panel data for 1977–1998. The net effect of guns on murder was approximately zero.

6. Discussion

Although not as consistent as the suicide studies reported earlier, the great majority of studies reported a positive association between gun availability and homicide (Tables 3 and 4). These findings are consistent with the first three hypotheses, namely that greater prevalence of guns is associated with a greater risk of homicide either because of the greater lethality of guns or because of the more destructive intentions of gun users. Third, higher homicide rates could have motivated people to buy guns for self-defense.

6.1. The instrumentality hypothesis

Although the positive relationship between gun possession or gun prevalence and murder is consistent with the instrumentality hypothesis, it is less clear how this interpretation could explain some of the findings of case-control studies reported earlier. Whereas it is plausible that access to a gun should make it easier for the aggressor to commit homicide, it is less clear why owning a gun should increase the risk of being murdered. To address this issue, one would need more information about these murders, most importantly about the ownership of the gun used in the homicide. For example, in the three studies that link homicide to household gun possession (Dahlberg et al., 2004; Kellermann et al., 1992; Wiebe, 2003), one would like to know whether the gun used in a killing was owned by deceased. Some suggestive evidence that this increase in homicide risk is the result of quarrels within a household comes from the studies of Dahlberg et al. (2004), Kellermann et al. (1993) and Wiebe (2003). These authors found that most victims knew their killer and 15% of the murders in the study of Wiebe were committed by family members. Dahlberg et al. (2004) further reported that the risk of gun-related homicide was only increased for individuals living with others. For those living alone, no increase was found. Finally, Kellermann et al. (1993) reported that previous periods of violence were more frequently reported in case rather than control families. Altogether, this suggests that the increase in the homicide risk of individuals living in households where a gun is present might be the result of guns increasing the risk of impulse killings in the course of some family quarrel.

In the studies in which gun possession was operationalized through handgun purchases, one would like to know whether the individuals had their gun with them when being killed and whether they used their gun for self-defence purposes. Contrary to the general belief that guns help gun owners to protect themselves, there is evidence that individuals who are in possession of a gun when involved in a gun assault are more likely to be shot (Branas, Culhane, Richmond, Ten Have, & Wiebe, 2009).

It is also plausible that the mere presence of a gun increases the likelihood of aggressive behavior. There is evidence that the presence of a gun leads people to behave more aggressively than they do in situations where no firearm is present (e.g., Anderson, Benjamin, & Bartholow, 1998; Bartholow, Anderson, Carnagey, & Benjamin, 2005; Berkowitz & LePage, 1967; Carlson, Marcus-Newhall, & Miller, 1990). The presence of a weapon increases the accessibility of aggression-related cognitions and ultimately increases the likelihood that a person behaves aggressively. This tendency to behave aggressively will be increased by the perception of power and invulnerability the presence of a gun might provide to the owner. Some supportive evidence comes from studies of road rage. People who carry firearms in their cars are more likely than others to engage in hostile behavior towards other drivers such as making obscene gestures or following other cars aggressively (Hemenway, Vrinotis, & Miller, 2005; Miller, Azrael, Hemenway, & Solop, 2002).

Finally, individuals who own guns might have characteristics that put them at an increased risk of being shot. For example, it is possible that these individuals own guns because they feel at risk for personal reasons that are unrelated to the safety of their residential area and thus not controlled in case-control studies. There is also evidence that firearm owners are more likely to be heavy drinkers than people, who do not own a firearm. For example, one study based on BRFSS data collected in several states of the US found that more firearm owners than those with no firearm at home have five or more drinks a day, drive under the influence of alcohol and have 60 or more drinks per month (Wintemute, 2011). Heavy alcohol consumption was most likely among individuals, who carried a firearm for protection and keeping it at home loaded and not locked away (Wintemute, 2011). Owners of an automatic or semiautomatic weapon are even more likely than other gun owners to binge drink frequently. Finally, heavy drinkers are also more likely to apply for a license to carry a concealed weapon (Schwaner, Furr, Negrey, & Seger, 1999). These findings are disturbing because alcohol is a risk factor for domestic violence and also for violent crime and homicide (Hemenway & Richardson, 1997). The link between alcohol and aggression has been consistently demonstrated in correlational and experimental studies (e.g., Subra, Muller, Begue, Bushman, & Delmas, 2010; for a review, see Bushman & Cooper, 1990).

6.2. *The lethal intent hypothesis*

One problem for this hypothesis is created by the evidence from case control studies that gun availability results in an increase in overall risk of suicide/homicide. According to this hypothesis, gun availability should result in substitution rather than an increase in suicides or homicides. In addition, there is evidence to suggest that the weapon used in an attack is much more responsible for the lethal outcome than the intent of the attacker (Phillips & Maume, 2007; Wells & Horney, 2002). Wells and Horney (2002) interviewed 704 newly incarcerated males who were convicted of felonies and sentenced to at least one year imprisonment. These individuals described a great number of potentially violent events. For each individual, the researchers chose one violent incident and one potentially violent incident where violence was avoided. For each incident, respondents were asked whether a gun was involved and whether they intended to seriously injure the opponent. The main dependent measure was the severity of the injuries of the opponent. The main finding was that if the opponent was injured, involvement of a gun resulted in sixtyfold increase in the odds of a serious injury.² Control for the seriousness of intentions did not affect this weapons effect in

² Wells and Horney (2002) also clarify a paradoxical finding reported by Kleck and McElrath (1991), namely that the risk of injury was less in a gun attack than in an attack involving other weapons. The reason for this is that many gun attacks miss their mark, but that the majority of these incidents involved long-distance attacks that could not have been made with another weapon such as a knife.

any way. Since this weapon effect occurred when the same individual faces various conflict situations with different weapons, it cannot be explained by individual differences of selection artifacts.

Similar results were reported by Phillips and Maume (2007) in a study based on interviews with 100 men imprisoned for aggravated assault or homicide that stemmed from an interpersonal conflict. They found that in conflicts where the respondent had a gun, 75% turn violent, compared to 24% when the respondent did not have a gun. The researchers then eliminated from the sample all violent incidents, where respondents brought the gun to the situation with the intention of using it in the conflict. Exclusion of cases where the availability of the gun was intentional rather than incidental does not eliminate the weapon effect. When a gun was available, 69% of instances turned violent compared to 33% when guns were not available. It is puzzling, however, that controlling for the respondents level of anger during the incident did not moderate the gun effect. One could have expected that the availability of a gun during a conflict would have been more important the angrier the respondent.

6.3. *Reverse causality: high homicide rates encourage gun possession*

As mentioned earlier, nearly half the people, who own guns, state that they bought them for self-protection (Cook & Ludwig, 1996). It is, therefore, highly plausible that the need for self-protection is at least partly responsible for the positive association between gun ownership and homicide. Newspaper reports about increased gun sales after mass shootings provide informal support for this interpretation (e.g., Fuchs, 2012; Whaba & Forsyth, 2012). Scientific support comes from a study by Kleck and Kovandzic (2009) who showed that the likelihood of handgun ownership is increased in cities with high crime rates, although effects were not mediated by the individual's own victimization experience. The authors argued that it was unlikely that individual handgun ownership was responsible for the crime rates; it was, therefore, probable that most gun owners bought guns for self-protection. Although one could argue with this reasoning, because individual handgun ownership ultimately determines rates of ownership, the analysis of Duggan (2001) reported earlier also provides evidence for reverse causation. Duggan (2001) found that an increase in crime rates increased hand gun ownership a year later. However, this effect was considerably smaller than the effect of increases in handgun ownership on crime rates.

It is important to note that the interpretation in terms of reverse causation is not a plausible explanation for the findings of individual-level studies. The individuals used as controls for persons killed in a homicide were usually matched with regard to the neighborhood they lived in and thus with regard to residential crime level. The case subjects should, therefore, not have been more motivated to buy guns than their controls. Thus, even though it is plausible that people living in more dangerous cities or neighborhoods in the USA are more likely to buy guns than individuals living in safe areas, this effect cannot fully explain the association between gun ownership and homicide reported earlier.

7. Conclusions

The findings of a positive association between homicide rates and gun ownership in macro-level study are most plausibly explained with the assumption that murder attempts committed with a firearm are likely to be more successful than those attempted with other means. However, as discussed earlier, the validity of conclusions from international studies is threatened by the fact that the variation in homicide rates between countries is only to a small part determined by the rates of gun possession. As mentioned earlier, the criminological literature on homicide does not even consider gun possession as a determinant of homicide rates (e.g., Land et al., 1990; Fajnzylber et al., 2002; McCall et al., 2010; Stolzenberg et al., 2006; Tcherni, 2001). In contrast, the findings of macro-level studies conducted on a national level are quite

supportive of an association between gun ownership rates and homicide (Bridges & Kunselman, 2004; Duggan, 2001; Gius, 2009; Hoskins, 2011; Kaplan & Geling, 1998; Miller, Hemenway et al., 2007; Price et al., 2004).+

Some of the international studies attempted to control for economic and cultural differences between countries. However, one can question whether such controls were really sufficient and whether the control data were reliable for studies that included highly developed as well as underdeveloped countries in their sample. This problem is aggravated by the fact that there does not appear to be agreement about which economic and demographic determinants of homicide are most important. It is, therefore, hardly surprising that of the six international studies, only two found overall homicide rates significantly associated with rates of gun ownership (Hemenway & Miller, 2000; Hoskins, 2001). In contrast, the findings of most macro-level studies conducted on a national level are quite supportive of an association between gun ownership rates and homicide.

There is also support for the assumption that guns do not merely serve as a substitute for other means of homicide, but that gun possession is associated with increases in overall homicide rates. All six individual-level studies that reported an association between gun possession and overall homicide rates found it to be significant. Of the eight macro level studies conducted on a national level that reported the association of gun possession to overall homicide rates, seven found a positive association (although only for illegal guns in the case of Stolzenberg & D'Alessio, 2000). Most impressively, the longitudinal analysis by Duggan (2001) reported that changes in gun ownership prospectively related to changes in overall homicide rates. Since most of these studies failed to report the correlation of gun availability and homicides committed by other means, these correlations could be partly or fully due to substitution of gun homicides for homicides by other means. However, Miller, Hemenway et al. (2007), who did report this correlation, found homicides by other means unrelated to gun ownership.

7.1. Do firearms protect individuals?

According to survey data reported earlier, 46% of all gun owners state that the need for self-protection was their primary reason for owning a gun (Cook & Ludwig, 1996). This raises the interesting question whether guns are an effective means of self-protection. There are two sources of data to address this question, namely survey data about defensive gun use (DGU) and objective measures. The survey data result in conflicting estimates. According to the nationally representative National Crime Victimization Survey, there are 108,000 DGU's each year (Cook & Ludwig, 1998). In contrast, a small survey conducted by Kleck and Geertz (1995) arrived at an estimate of 2.5 million DGU per year. Because DGU is a relatively rare event, these estimates are based on answers of a very small proportion of respondents and can therefore be greatly influenced by false reporting. For example, Cook and Ludwig report data from a nationally representative telephone survey conducted in 1994. Of the 3268 respondents, 45 reported DGU's during the past 12 month directed against a human. This would imply 3.1 million DGU's per year for the US population, an estimate similar to that of Kleck and Geertz (1995). However, respondents in the Cook and Ludwig survey were also asked to report the crime against which DGU was successfully used and these results are difficult to reconcile with the number of crimes estimated from victimization surveys. As Cook and Ludwig (1998) conclude, according to these estimates "every rape or rape attempt was thwarted by DGU, as was one of five aggravated assaults and two of five robberies" (p. 123).

More valid estimates of the protective value of owning a gun might, therefore, be based on the relationship between gun possession and the risk of becoming the victim of homicide, robbery, or burglary. If the possession of a gun really protected individuals against violent crimes,

there should be an inverse relationship between gun possession and violent crime. As we discussed earlier, this does not appear to be the case for homicide. Household or personal gun possession nearly doubles the risk for individuals becoming the victim of a homicide. There is also little evidence that gun ownership protects individual households against being burgled. Cook and Ludwig (2002), who related local rates of gun ownership to residential burglary for the years 1994 to 1998, found a positive relationship. Residential areas with high level of household gun ownership had a higher rate of burglaries than areas with low levels of gun ownership. Since gun ownership was used as a lagged variable, an interpretation in terms of reverse causation seems unlikely.

Similar results were reported by Duggan (2001), who found a positive relationship between state-level changes in gun ownership and future increases in robberies, aggravated assault, and rape. Finally, Hoskins (2001) found gun availability positively related to aggravated assault, but unrelated to burglary rates. As Cook and Ludwig (2002) argued, although guns in homes may pose as a threat to burglars, they might also serve as an inducement, because they are valuable commodities that can be easily turned into cash.

The most persuasive evidence against the assumption that guns protect individuals against criminal attacks comes from a case-control study of people either killed or wounded by gunshots in an assault in Philadelphia between 2003 and 2006 (Branas et al., 2009). Case subjects included fatal gun assaults and gun assaults in which the victim had at least some chance to resist the threat posed by an offender. Gun possession at the time of the shooting was determined by police observations. (Shootings of police officers were not included.) Case participants were matched with control participants with regard age, gender and race. Compared to control participants, case participants were significantly more often Hispanic, working in high risk occupations, less educated, and had a greater frequency of prior arrests. Controlling for these factors, individuals who were in possession of a gun were 4.46 times more likely to be shot in an assault than those not in possession and 4.23 times more likely to fatally shot. In an assault where the victim had at least some chance to resist, the chance to be shot was 5.45 times greater for individuals in possession of a gun. Thus, although the evidence is limited, it is rather consistent: There is no support for the assumption that gun possession protects individuals against becoming victims of crime.

8. General discussion

The great majority of findings about the association of firearm availability and suicide or homicide reviewed in this article is consistent the assumption that easy access to firearms increases the risk of dying from violent causes. With few exceptions, studies found gun ownership positively associated with gun-related suicides and homicides. Since there are hardly any studies finding a negative relationship between gun availability and homicide, one can reject the self-defense and deterrence hypothesis. Thus, one can clearly conclude that more guns are associated with more rather than fewer violent deaths. Furthermore, there is also evidence that guns do not merely serve as substitutes for other means of killing, but increase the overall rates of suicide and homicide.

Although the findings reported in this review are consistent with the assumption that access to a gun increases the risk of suicide or homicide (e.g., from individual-level studies), there is also support for the assumption that the positive association is partly due to reverse causality. Because guns are an effective means of committing suicide, people who plan to commit suicide sometimes buy a gun to do so. Similarly, while access to guns makes it easier to commit murder, people who live in high crime areas often buy guns for self-protection. These two interpretations are not incompatible. However, with regard to homicide rates, they are likely to result in a vicious circle: Easy access to guns increases homicide rates and increased homicide rates motivate people to buy guns for self-protection.

It is, therefore, ironic that this belief in the protection offered by owning a gun is an illusion. Because this need for self-protection is likely to be one of the roots of people's resistance to stricter gun laws, it would be important to gain a better understanding of the bases of this belief that is difficult to understand from a European perspective. Most Europeans would not think of needing a gun for protection. So why do Americans feel in need of guns? One obvious reason would be the relatively high rate of homicides. To reduce this need one would, therefore, need to further decrease homicide rates. Another strategy, however, would be to persuade people that owning a gun is more likely to kill them than to protect them against crime.

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