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A longitudinal ecological study of household firearm ownership and firearm-related deaths in the United States from 1999 through 2014: A specific focus on gender, race, and geographic variables

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Short Title: Firearm Deaths

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Abstract

Firearms have a longstanding tradition in the United States (US) and are viewed by many with iconic stature with regards to safety and personal freedom. Unfortunately, from a public health point of view, firearm-related deaths (FRDs) in the US have reached a crisis point with an estimated more than 31,000 deaths and 74,000 nonfatal injuries resulting from firearms each year. This longitudinal ecological study analyzed variations in the FRDs following firearm assaults (FAs), and law enforcement incidents involving a firearm (LEIF) in comparison to variations in household firearm ownership (HFO) among different geographic and demographic groups in the US from 1999-2014. The Underlying Cause of Death database was examined on the CDC Wonder online interface. Records coded with ICD-10 codes: FA (X93 – assault by handgun discharge, X94 – assault by rifle, shotgun, and larger firearm discharge, or X95 - assault by other and unspecified firearm discharge) and LEIF (Y35.0) were examined, and the prevalence of HFO was determined using the well-established proxy of the percentage of suicides committed with a firearm. Gender, ethnicity, Census Division, and urbanization significantly impacted the death rates from FA and LEIF. Significant direct correlations between variations in HFO and death rates from FAs and LEIF were observed. Understanding the significant impacts of gender, race, Census Division, and urbanization status may help shape future public health policy to promote increased firearm safety.

Key Words: Assault, Death, Gun, Firearm, Law Enforcement

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Introduction

Firearms have a longstanding tradition in the United States (US). Firearms in the US are viewed by many with iconic stature with regards to safety and personal freedom. The second amendment to the US Constitution was adopted on December 15, 1791 and states, "A well-regulated militia being necessary to the security of a free State, the right of the People to keep and bear arms shall not be infringed." The issue of firearm ownership has repeatedly reached national prominence in the US, and most recently, in June 2008, in a 5-to-4 decision of the US Supreme Court in the case of *District of Columbia v. Heller*. In that decision, a ban on handgun ownership was struck down and a law requiring all firearms in the home to be locked was ruled to violate the Second Amendment of the US Constitution (Miller et al., 2008). It was reported that US household firearm ownership (HFO) exceeds 50% (Siegel et al., 2013).

US firearm-related deaths (FRDs) have reached a crisis point with more than 31,000 deaths and 74,000 nonfatal injuries annually (Siegel et al., 2013). Firearms in the US cause more than 85 deaths and 200 nonfatal injuries per day. Annually there are 11,000 firearm-related homicides, which is more than all US troops killed in the last decade in Iraq and Afghanistan combined (Mozaffarian et al., 2013). In addition, in recent years FRDs following law enforcement incidents involving a firearm (LEIF) have received increasing national and international prominence with a number of high profile cases covered in the news media (The Washington Post, 2015). FRDs have contributed to an ongoing national debate about LEIF, and, especially how LEIF deaths impact various minority groups and geographic areas, and how, if at all, HFO and LEIF death rates relate. LEIF, in the context of this study, should not be confused with death among law enforcement officers resulting from firearms, a phenomenon which has been well-studied previously (Blair et al., 2016). Overall, LEIF is an area of research that has not received much focus in the literature and should be examined further.

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Unfortunately, all too often when considering HFO and FRDs, factors relating to regional, partisan, and personal preferences may have negatively impacted evidence-based scientific investigation and policy considerations (Mozaffarian et al., 2013). In order to address this situation a comprehensive, multidimensional strategy benefiting from lessons learned from previous successful public health campaigns against problems such as tobacco use, alcoholism, and motor vehicle safety is a necessity (Hemenway, 2001).

The purpose of this study was to analyze longitudinal trends in FRDs following firearm assaults (FAs) and LEIF by different geographic and demographic variables in the US from 1999-2014. This study also examined potential correlation between differences in HFO rates and the FRDs following FAs and LEIF.

The present study is differentiated from other studies because it is the first to employ the Underlying Cause of Death database using the publically available CDC Wonder online interface. As such, it was possible to examine on a longitudinal basis by geographic areas detailed population demographics (gender, race, urbanization) and medical outcomes (i.e., ICD-10 coding) from the Underlying Cause of Death database.

Methods

Geographic and demographic variables were hypothesized to significantly impact the FRDs following FAs and LEIF. HFO rates were hypothesized to significantly relate to FRDs following FAs and LEIF mediated by geographic and demographic variables. The US Centers for Disease Control and Prevention (CDC) Wonder online interface was used to examine mortality data (CDC, 2016). The specific data examined was: FRDs by age, gender, race, for the nation overall, by state, by US Census Region, and urbanization.

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Mortality Data

The Underlying Cause of Death database was examined on the CDC Wonder online interface. The database is based on information from all death certificates filed in the fifty states and the District of Columbia. Deaths of nonresidents are excluded. Mortality data from death certificates are coded by the states and provided to the National Center for Health Statistics (NCHS) of the US CDC through the Vital Statistics Cooperative Program or coded by NCHS from copies of the original death certificates provided to NCHS by State registration offices.

The Underlying Cause of Death database was examined by time and location variables for deaths reported from 1999-2014 with a location in the fifty US states and the District of Columbia. The Underlying Cause of Death database uses the International Classification of Disease, Tenth Revision (ICD-10) codes. This study examined records coded with ICD-10 codes: FA (X93 – assault by handgun discharge, X94 – assault by rifle, shotgun, and larger firearm discharge, or X95 - assault by other and unspecified firearm discharge) and LEIF (Y35.0). In addition, in order to determine FRDs following FAs and LEIF, general population estimates were utilized from the Underlying Cause of Death database based upon population bridged-race estimates from the US Census Bureau estimates of US national, state, and county resident populations. All sub-national data representing 0 to 9 deaths and the corresponding denominator population figures were not reported to protect confidentiality. Thus, the data analyzed in this study complied with the suppression rules of WONDER/WISARS uses.

The FRDs following FAs and LEIF, and the general population estimates were examined for detailed demographic information, including: gender (male or female), race (Hispanic; non-Hispanic White = White; non-Hispanic Black or African American = Black or African American; non-Hispanic Asian or Pacific Islander = Asian or Pacific Islander; or non-Hispanic

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American Indian or Alaska Native = American Indian or Alaska Native), Census Division (Division 1-9), and 2006 urbanization (large central metro, large fringe metro, medium metro, small metro, micropolitan, or noncore). Table 1 summarizes the overall demographic breakdown of the populations examined.

Prevalence of Household Firearm Ownership Data

The prevalence of HFO was determined using the well-established proxy of the percentage of suicides committed with a firearm. This was calculated by dividing all intentional self-harm by firearm deaths (ICD-10 codes: X72-X74) by all intentional self-harm deaths (ICD-10 codes: X60-X84). This measure has been extensively validated in previous studies, it was determined to be the best proxy available of many previously tested, and significantly correlates with survey measures of HFO (Killias, 1993). In this study, the overall prevalence of HFO was determined for the geographical areas and time periods examined (Model I). In addition, the prevalence of HFO was evaluated to take into account the potential differences introduced by the specific demographic groups (i.e., gender, race, or urbanization) examined within geographical areas and time periods (Model II).

Statistical Analyses

In this study, the statistical package contained in StatsDirect (Version: 3.0.152) was utilized and in all statistical analyses a two-sided p-value < 0.05 was considered statistically significant. The null hypotheses for each of the statistical tests undertaken in this study were that there would be no differences between the groups examined.

The data were initially examined to determine if there were demographic differences among FRDs following FAs or LEIF in comparison to the overall US population. The data were categorical variables, so a χ^2 statistic was employed. The logistic regression test statistic

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examined the potential correlation using a proportion ratio (PR) between FRDs following FAs or LEIF and the prevalence of HFO broken down by Census Division, Census Division by year, state, and state by year. The Spearman's rank correlation statistic was utilized to examine the correlation between FRDs following FAs or the LEIF and the prevalence of HFO by demographic groups while holding time and geographic variables constant.

Results

Table 1 reveals the demographic characteristics examined among FRDs following FAs and LEIF in comparison to the overall US population. Overall, FRDs following FAs clustered among males, Blacks, Large Central Metro areas, and the Census Division areas of South Atlantic and West South Central and FRDs following LEIF clustered among males, Blacks, Large Central Metro areas, and the Census Division areas of Mountain and Pacific.

Specifically, it was observed that the FRDs among males and females following FAs and LEIF were significantly different from their percentages of the overall US population. The male:female ratios for FRDs following FAs=5.4 and LEIF=24.3 were significantly higher than the overall US population = 0.97.

The majority of FRDs following FAs occurred in Blacks (54.07%) even though Blacks represented a much smaller percentage of the overall US population (12.68%). Similarly, the percentage of FRDs following LEIF among Blacks (25.89%) was significantly increased relative to their percentage of the overall US population (12.68%). The percentage of FRDs following FAs among Whites (25.19%) and Asian or Pacific Islanders (1.76%) and the percentage of FRDs following LEIF among Whites (49.82%) and Asian or Pacific Islanders (2.25%) were both significantly less than the percentage of Whites (66.54%) and Asian or Pacific Islanders (4.87%) in the overall US population. Among Hispanics or Latinos, there were slightly increased

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percentage of FRDs following FA (18.15%) and LEIF (20.16%) compared to their percentage of the overall US population (15.08%). Finally, the percentage of FRDs following LEIF among American Indian or Alaska Natives (1.88%) was significantly increased relative to their percentage of the overall US population (0.83%), but the percentage of FRDs following FAs among American Indian or Alaska Natives (0.83%) was no different from their percentage of the overall US population (0.83%).

An examination of the percentage of FRDs following FAs and LEIF by Census Division revealed significant differences for many Census Divisions in comparison to the percentage of each Census Division in the overall US population. The percentage of FRDs following FAs in New England (1.84%) and Middle Atlantic (10.81%) and the percentage of FRDs following LEIF in New England (2.38%) and Middle Atlantic (7.36%) were significantly lower than their respective percentage of the overall US population. FRDs following FAs in South Atlantic (23.21%), East South Central (8.44%), and West South Central (14.25%) were significantly higher than their percentage of the overall US population. FRDs following LEIF in Mountain (13.01%) and Pacific (27.84%) significantly exceeded their percentage of the overall US population.

An examination of 2006 urbanization status revealed that the percentages of FRDs following FA (49.48%) and LEIF (37.70%) in large central metro urban areas significantly exceeded their percentages of the overall US population. By contrast, the percentage of FRDs following FAs and LEIF were significantly lower in large fringe metro, medium metro, small metro, micropolitan (non-metro), and noncore (non-metro) in comparison to their respective percentages of the US overall population.

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Table 2 summarizes FRDs following FAs, LEIF, and the percent household firearm ownership by Census Division from 1999-2014. The overall FRDs following FAs was 38.8 per 1,000,000 people. The lowest was in New England (15.0 per 1,000,000 people) and the highest was in East South Central (54.8 per 1,000,000 people). The overall FRDs following LEIF was 1.2 per 1,000,000 people. The lowest was in New England (0.6 per 1,000,000 people) and the highest in Mountain (2.3 per 1,000,000 people). An examination of the percentage of HFO revealed that a majority of US households owned firearms (52.11%). New England had the lowest HFO percentage (34.84%) and East South Central had the highest percentage of HFO (67.56%).

Table 3 reveals significantly increased PRs between increasing HFO and increasing FRDs following FAs when the data were analyzed by Census Division (PR = 1.0230), by Census Division and by year (PR = 1.0221), state (PR = 1.0151), and state and year (PR = 1.0151). Table 4 also reveals significantly increased PRs between increasing HFO and increasing FRDs following LEIF when the data were analyzed by Census Division and year (PR = 1.00162) and state (PR = 1.00449).

Table 5 evaluates the correlation between HFO and FRDs following FAs and LEIF for different demographic groups. A significant correlation was observed between increasing HFO (using Model I and Model II) and increasing FRDs following FAs for both males and females. Interestingly, the correlation was stronger for females (Model I Rho=0.936 and Model II Rho=0.946) than for males (Model I Rho=0.788, Model II Rho= 0.775). A significant correlation between increasing HFO (using Model I and Model II) and increasing FRDs following FAs for Hispanic or Latino, White, and Asian or Pacific Islander racial groups was observed. The strength of the correlations in descending order by racial group were Whites > Asian or Pacific

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Islander > Hispanic or Latinos. No significant correlations were observed among Blacks and American Indian or Alaskan Natives. For Blacks, there was a significant inverse relationship between HFO (using Model I and Model II) and FRDs following LEIF (Model I Rho=-0.372, Model II Rho=-0.367). An examination of 2006 urbanization status revealed a significant increasing correlation between increasing HFO (Model I and Model II) and an increasing FRDs following FAs for each 2006 urbanization category examined, and were as follows in descending order: micropolitan and noncore (non-metro) > medium metro and small metro > large fringe metro > large central metro. There was a significant increasing correlation between increasing HFO (Model II) and increasing FRDs following LEIF only for the large central metro 2006 urbanization category.

Discussion

The longitudinal ecological epidemiological results observed in this study were consistent with the hypothesized relationships between HFO rates, FRDs, and geographic/demographic variables. Demographic variables of gender, race, geography, and urbanization were associated with significant differences in FRDs following FAs and LEIF. There were significant direct correlations between increasing HFO rates and increasing FRDs following FAs and LEIF when the data were examined by increasingly refined geographic and time variables. Finally, significant differences in the correlations between the rates of HFO and FRDs following FAs and LEIF were observed when the data were examined by gender, race, or urbanization.

Consistent with this study, previous studies showed HFO was associated with an increased risk of being a homicide victim (Kellermann et al., 1993; Bailey et al., 1997; Cummings et al., 1997). Other studies revealed higher rates of HFO and higher rates of homicide by correlating them across different countries (Killias, 1993; Killias et al., 2001; Hemenway and

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Miller, 2000; Hemenway et al., 2002; Sloan et al., 1988; Centerwall, 1991). The ability to consider the variations in all of these variables within a single country (i.e., the US) in this study provides a strong line of research. Although this is a strength in terms of homogeneity, it is also a weakness in terms of generalizability.

A number of studies have explored the relationship between firearm prevalence and homicide in the US (Seigel et al., 2013; Kleck, 1991). These previous cross-sectional studies revealed a positive relationship between firearm ownership at the neighborhood (Shenassa et al., 2006), county (Cook et al., 2006), regional (Kaplan et al., 1998; Miller et al., 2002a,b,c), or state level (Cook et al., 2006; Kaplan et al., 1998; Miller et al., 2002a,b,c, 2007; Price et al., 2004; Seitz, 1972; Lester, 1988, 1993; Muran et al., 2004; Rosenfeld et al., 2007; Ruddell and Mays, 2004; Fleeger et al., 2013) and homicide rates. There are only a few studies that have analyzed HFO and FRDs across multiple years (Sorenson et al., 2001; Cook et al., 2006; Miller et al., 2002a,b,c). In addition, even fewer have analyzed data more recent than 1999, and the most recent data analyzed was updated to 2010 (Siegel et al., 2013).

The results of this study build upon and extend further the results reported in the aforementioned studies for several reasons. First, this study utilized the CDC Wonder online interface. As such, other researchers can use the CDC wonder online interface to confirm and extend the finding made in this study. Additionally, the CDC Wonder online interface provides a more comprehensive means to analyze the potential relationship between HFO, FRDs, and demographic/geographic variables. By contrast many previous studies analyzed non-public data, and may potentially suffer from data collection difficulties. Second, the scale of differences in the various variables examined in this study is much larger than in many previous studies. This study analyzed HFO and FRDs generated over more than a decade time period from multiple

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geographic locations in the US. By contrast, previous studies mostly analyzed subsets of the population in the US. Third, this study integrated demographic variables such as gender, race, and urbanization as part of the assessments undertaken. None of the previous studies were able to undertake such detailed analyses.

The results observed in this study regarding FRDs following LEIF are a relatively new finding in the area of FRDs. Consistent with the observations made in this study, previous studies have identified that LEIF deaths are a small percentage of the overall number of FRDs (Lyons et al., 2016). Yet, the results in this study revealed for the first time detailed demographic and HFO factors associated with FRDs following LEIF. FRDs following LEIF clustered among males, Blacks, large central metro areas, and the Census Division areas of Mountain and Pacific. In addition, increasing HFO percentages were associated with increasing FRDs following LEIF, with the notable exception of Blacks, where there was an inverse relationship. This is an area of study that should be examined further in future studies.

Strengths/Limitations

An important strength of this study was the overall study design. This study is apparently the first to employ the Underlying Cause of Death database using the publically available CDC Wonder online interface. As a consequence, it was possible to examine on a longitudinal basis by geographic areas detailed population demographics (gender, race, urbanization) and medical outcomes (i.e., ICD-10 coding) from the Underlying Cause of Death database. In addition, the data examined were collected independent of the study design employed.

Another important strength of this study was the consistency of the correlations observed. It was found in every statistical analysis that the magnitude and the direction of the phenomena

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observed were consistent. This argues against the phenomena observed being the result of statistical chance.

A potential limitation of this study was that it employed an ecological study design. As such, it was not possible to examine the exact exposure history of each individual, and to determine a direct cause and effect relationship between the exposure and outcome variables. In future studies, it would be worthwhile to further examine the consistency of the phenomena observed in this study with individual longitudinal records of HFO and FRDs.

Another potential limitation of this study was that only 5,750 FRDs were observed following LEIF. As a consequence, as FRDs following LEIF were examined by location, time, and demographic variables the numbers became much smaller, and in some cases, it was not possible to analyze any numbers at all. The result of this limitation was a potential decreased statistical power to find potential correlations between HFO rates and the FRDs following LEIF. Despite this limitation, given the breadth and the scope of the data examined, it was still possible to evaluate potential statistical correlations in many cases. It would be worthwhile in future studies to further explore the consistency of the phenomena observed in this study with other populations and other databases.

It is also a possible limitation of this study that there may have been errors in identifying/recoding the true cause of death in the Underlying Cause of Death database. In addition, some of the deaths examined in this study while recorded as occurring in the US may have occurred in non-US citizens, especially, among minority populations. It is presumed that if such inaccuracies occurred in the data that they would have occurred with similar frequency among the groups examined. It is possible that such inaccuracies may not have occurred with similar frequency among the groups examined. but this was deemed to be of low probability. If

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such phenomena were present in the data examined, it would have reduced the statistical power of this study.

It is also a potential limitation of this study that interactions between the various demographic variables and FRDs were not undertaken. For example, the interaction of the demographic variables of race, geography, gender, and urbanization may be even more related to FRDs. It is recommended that future studies explore this possible phenomenon.

Conclusion

This study is the first to evaluate the Underlying Cause of Death database using the publically available CDC Wonder online interface to examine variations in HFO and FRDs in the US. Significant relationships between variations in HFO and the FRDs following FAs and LEIF were observed across different geographic regions of the US from 1999-2014. Gender, race, Census Division, and urbanization status were observed to significantly impact the relationship between HFO and FRDs. In summary, for FRDs following FA, there was a clustering among males, Blacks, Large Central Metro areas, and the Census Division areas of South Atlantic and West South Central and for FRDs following LEIF there was a clustering among males, Blacks, Large Central Metro areas, and the Census Division areas of Mountain and Pacific. The study results indicate that FRDs following FAs and LEIF are a health disparity issue of critical proportion. Future studies should examine these phenomena in other populations and also examine how to minimize the FRDs following FAs and LEIF on the population within the legal limits of the Bill of Rights. Finally, firearm ownership by law abiding citizens in the US is a fundamental right, but it is hoped that the results of this study will provide important insights into how to shape future public health policy to promote increased firearm safety in the US and beyond.

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References

Bailey JE, Kellermann AL, Somes G, Banton JG, Rivara F, Rushforth NB. Risk factors for violent death of women in the home. Arch Intern Med 1997;157(7):777-782.

Blair JM, Fowler KA, Betz CJ, Baumgardner JL. Occupational Homicides of Law Enforcement Officers, 2003-2013: Data From the National Violent Death Reporting System. Am J Prev Med. 2016;51(5S3):S188-S196.

Centers for Disease Control and Prevention. CDC Wonder. www.wonder.cdc.gov. Page last reviewed July 12, 2016. Accessed on August 29, 2016.

Centerwall BS. Homicide and the prevalence of handguns: Canada and the United States, 1976 to 1980. Am J Epidemiol 1991;134(11):1245-1260.

Cook PJ, Judwig J. The social costs of gun ownership. J Public Econ 2006;90(1-2):379-391.

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(6):974-978.

Fleeger EQ, Lee LK, Monuteaux MC, Hemenway D, Mannix R. Firearm legislation and firearm-related fatalities in the United States. JAMA Intern Med 2013;173(9):732-740.

Hemenway D. The public health approach to motor vehicles, tobacco, and alcohol, with applications to firearms policy. J Public Health Policy 2001;22(4):381-402.

ACCEPTED MANUSCRIPT

Hemenway D, Miller M. Firearm availability and homicide rates across 26 high-income countries. J Trauma 2000;49(6):985-988.

Hemenway D, Shinoda-Tagawa T, Miller M. Firearm availability and female homicide victimization rates among 25 populous high-income countries. J Am Med Womens Assoc 2002;57(2):100-104.

Kaplan MS, Geling O. Firearm suicides and homicides in the United States: regional variations and patterns of gun ownership. Soc Sci Med 1998;46(9):1227-1233.

Kellermann AL, Rivara FP, Rushforth NB, et al. Gun ownership as a risk factor for homicide in the home. N Engl J Med 1993;329(15):1084-1091.

Kleck G. Point blank: guns and violence in America. Hawthorne, N.Y.: Aldine de Gruyter, 1991.

Killias M. International correlations between gun ownership and rate of homicide and suicide. Can Med Assoc J 1993;148(10):1721-1725.

Killias M, van Kesteren J, Rindlisbacher M. Guns, violent crime, and suicide in 21 countries. Can J Crimol 2001;43(4):429-448.

Lester D. Firearm availability and the incidence of suicide and homicide. Acata Psychiatr Belg 1988;88(5-6):387-393.

Lester D. Firearm deaths in the United States and gun availability. Am J Public Health 1993;83(11):1642.

Lyons BH, Fowler KA, Jack SP, Betz CJ, Blair JM. Surveillance of violent deaths – National Violent Death Reporting System, 17 states, 2013. MMWR Surveill Summ 2016;65(10):1-42.

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Miller M, Hemenway D. Guns and suicide in the United States. N Engl J Med 2008;359:989-991.

Miller M, Azrael D, Hemenway D. Rates of household firearm ownership and homicide across US regions and states, 1988-1997. Am J Public Health 2002a;92(12):1988-1993.

Miller M, Azrael D, Hemenway D. Firearm deaths among women. J Urban Health 2002b;79(1):26-38.

Miller M, Azrael D, Hemeway D. Firearm availability and unintentional firearm deaths, suicide, and homicide among 5-14 year olds. J Trauma 2002c;52(2):267-274.

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(3):656-664.

Mozaffarian D, Hemenway D, Ludwig DS. Curbing gun violence: lessons from public health successes. JAMA 2013;309(6):551-2.

Muran 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(8):335-340.

Price JH, Thompson AJ, Dake JA. Factors associated with state variations in homicide, suicide, and unintentional firearm deaths. J Community Health 2004;29(4):271-283.

Rosenfeld R, Baumer E, Messner SF. Social trust, firearm prevalence, and homicide. Ann Epidemiol 2007;17(2):119-125.

Ruddell R, Mays GL. State background checks and firearm homicides. J Crim Justice 2005;33(2):127-136.

ACCEPTED MANUSCRIPT

Seitz ST. Firearms, homicides, and gun control effectiveness. Law Soc Rev 1972;6(4):595-614.

Shenassa ED, Daskalakis C, Buka SL. Utility of indices of gun availability in the community. J Epidemiol Community Health 2006;60(1):44-49.

Siegel M, Ross CS, King C 3rd. The relationship between gun ownership and firearm homicide rates in the United States, 1981-2010. Am J Public Health 2013;102(11):2098-105.

Sloan JH, Kellermann AL, Reay DT, et al. Handgun regulations, crime, assaults, and homicide: a tale of two cities. N Engl J Med 1988;319(19):1256-1262.

Sorenson SB, Berk R. Handgun sales, beer sales, and youth homicide, California, 1972-1993. J Public Health Policy, 2001;22(2):182-197.

The Washington Post. Fatal police shootings in 2015 approaching 400 nationwide. https://www.washingtonpost.com/national/fatal-police-shootings-in-2015-approaching-400-nationwide/2015/05/30/d322256a-058e-11e5-a428-c984eb077d4e_story.html?utm_term=.aa760dcb4875. Published May 30, 2015. Accessed on February 10, 2017.

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Table 1. A demographic summary of the populations examined from 1999-2014

Characteristic Examined	Assault by Firearm Deaths[1] ICD-10 codes: X93, X94, X95	Law Enforcement Incidents Involving a Firearm Deaths[1] ICD-10 codes: Y35.0	Overall Population
Gender			
Males	156,692 (84.37%)[2]	5,523 (96.05%)[2]	2,354,594,299 (49.14%)
Females	29,025 (15.63%)	227 (3.95%)	2,436,605,757 (50.86%)
Race[2]			
Hispanic or Latino	33,532 (18.15%)[2]	1,156 (20.16%)[2]	722,513,667 (15.08%)
Black or African American	99,879 (54.07%)	1,485 (25.89%)	607,597,034 (12.68%)
White	46,535 (25.19%)	2,857 (49.82%)	3,187,900,289 (66.54%)
Asian or Pacific Islander	3,250 (1.76%)	129 (2.25%)	233,386,448 (4.87%)
American Indian or Alaska Native	1,536 (0.83%)	108 (1.88%)	39,802,618 (0.83%)
Census Division			
Division 1: New England (CT, RI, MA, VT, NH, ME)	3,422 (1.84%)[2]	137 (2.38%)[2]	228,597,339 (4.77%)
Division 2: Middle Atlantic (NY, PA, NJ)	20,073 (10.81%)	423 (7.36%)	647,489,850 (13.51%)
Division 3: East North Central (WI, IL, IN, MI, OH)	29,960 (16.13%)	671 (11.67%)	736,376,389 (15.37%)
Division 4: West North Central (ND, SD, NE, KS, MN, IA, MO)	8,175 (4.40%)	277 (4.82%)	320,762,150 (6.69%)
Division 5: South Atlantic (WV, MD, DE, DC, VA, NC, SC, GA, FL)	43,096 (23.21%)	1,074 (18.68%)	913,694,966 (19.07%)
Division 6: East South Central (KY, TN, MS, AL)	15,682 (8.44%)	218 (3.79%)	286,336,410 (6%)
Division 7: West South Central (TX, OK, AR, LA)	26,466 (14.25%)	601 (10.45%)	553,628,510 (11.55%)
Division 8: Mountain (NV, ID, UT, AZ, NM, CO, WY, MT)	10,673 (5.75%)	748 (13.01%)	331,275,042 (6.91%)
Division 9: Pacific (WA, OR, CA)	28,170 (15.17%)	1,601 (27.84%)	773,039,400 (16.13%)

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2006 Urbanization			
Large Central Metro	91,899 (49.48%)[2]	2,168 (37.70%)[2]	1,415,582,280 (29.55%)
Large Fringe Metro	29,334 (15.8%)	1,094 (19.03%)	1,158,089,103 (24.17%)
Medium Metro	32,075 (17.27%)	1,142 (19.86%)	957,664,196 (19.99%)
Small Metro	11,676 (6.29%)	514 (8.94%)	457,552,362 (9.55%)
Micropolitan (non-metro)	12,579 (6.77%)	489 (8.50%)	490,339,760 (10.23%)
Noncore (non-metro)	8,154 (4.39%)	343 (5.97%)	311,972,355 (6.51%)

[1] The values were derived by adding the values for each year examined to calculate the cumulative numbers presented in the table.

[2] A total of 185,717 assault by firearm deaths were identified but 985 had unknown Hispanic origin and were excluded from this table. A total of 5,750 law enforcement incidents involving firearm deaths were identified but 15 had unknown Hispanic origin and were excluded from this table.

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Table 2. A summary of the firearm variables examined for each Census Division from 1999-2014

Census Division	Assault by Firearm Death Rate per 1,000,000 (95% CI)	Law Enforcement Incidents Involving a Firearm Death Rate per 1,000,000 (95% CI)	Percent Household Firearm Ownership (95% CI)
Division 1: New England (CT, RI, MA, VT, NH, ME)	15.0 (14.5 to 15.5)	0.6 (0.5 to 0.7)	34.84 (34.06 to 35.64)
Division 2: Middle Atlantic (NY, PA, NJ)	31.0 (30.6 to 31.4)	0.7 (0.6 to 0.7)	39.87 (39.35 to 40.39)
Division 3: East North Central (WI, IL, IN, MI, OH)	40.7 (40.2 to 41.1)	0.9 (0.8 to 1.0)	48.53 (48.05 to 49.01)
Division 4: West North Central (ND, SD, NE, KS, MN, IA, MO)	25.5 (24.9 to 26.0)	0.9 (0.8 to 1.0)	53.15 (52.44 to 53.87)
Division 5: South Atlantic (WV, MD, DE, DC, VA, NC, SC, GA, FL)	47.2 (46.7 to 47.6)	1.2 (1.1 to 1.2)	57.05 (56.61 to 57.49)
Division 6: East South Central (KY, TN, MS, AL)	54.8 (53.9 to 55.6)	0.8 (0.7 to 0.9)	67.56 (66.75 to 68.38)
Division 7: West South Central (TX, OK, AR, LA)	47.8 (47.2 to 48.4)	1.1 (1.0 to 1.2)	60.64 (60.05 to 61.24)
Division 8: Mountain (NV, ID, UT, AZ, NM, CO, WY, MT)	32.2 (31.6 to 32.8)	2.3 (2.1 to 2.4)	55.67 (55.06 to 56.28)
Division 9: Pacific (WA, OR, CA, AK, HI)	36.4 (36.0 to 36.9)	2.1 (2.0 to 2.2)	44.88 (44.43 to 45.33)
Total	38.8 (38.6 to 38.9)	1.2 (1.2 to 1.2)	52.11 (51.92 to 52.3)

The prevalence of household firearm ownership was determined using the well-established proxy of the percentage of suicides committed with a firearm. This was calculated by dividing all intentional self-harm by firearm deaths (ICD-10 codes: X72-X74) by all intentional self-harm deaths (ICD-10 codes: X60-X84).

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Table 3. A summary of the correlation between variations in percent household firearm ownership and variations in the assault by firearm death rate from 1999-2014

Breakdown of Data Examined (# of obs)	**Logistic Regression Statistic**
Census Division (n = 9)	Proportion Ratio = 1.0230 95% CI = 1.0225 to 1.0236 Equation: Assault by Firearm Death Rate = -11.340 + 0.023 (Percent Household Firearm Ownership)
Census Division by Year (n = 144)	Proportion Ratio = 1.0221 95% CI = 1.0216 to 1.0226 Equation: Assault by Firearm Death Rate = -11.297 + 0.022 (Percent Household Firearm Ownership)
State (n = 51)	Proportion Ratio = 1.0151 95% CI = 1.0147 to 1.0155 Equation: Assault by Firearm Death Rate = -10.926 + 0.015 (Percent Household Firearm Ownership)
State by Year (n = 725)	Proportion Ratio = 1.0151 95% CI = 1.0147 to 1.0156 Equation: Assault by Firearm Death Rate = -10.922 + 0.015 (Percent Household Firearm Ownership)

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Table 4. A summary of the correlation between variations in percent household firearm ownership and variations in the law enforcement incidents involving a firearm death rate from 1999-2014

Breakdown of Data Examined (# of obs)	**Logistic Regression Statistic**
Census Division (n = 9)	Proportion Ratio = 1.00275 95% CI = 0.9997 to 1.00581 Equation: Law Enforcement Incidents Involving a Firearm Death Rate = -13.774 + 0.00275 (Percent Household Firearm Ownership)
Census Division by Year (n = 129)	Proportion Ratio = 1.00162 95% CI = 1.00108 to 1.00215 Equation: Law Enforcement Incidents Involving a Firearm Death Rate = -13.799 + 0.0016 (Percent Household Firearm Ownership)
State (n = 47)	Proportion Ratio = 1.00449 95% CI = 1.00218 to 1.00682 Equation: Law Enforcement Incidents Involving a Firearm Death Rate = -13.846 + 0.00449 (Percent Household Firearm Ownership)
State by Year (n = 172)	Not Enough Data

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Table 5. A summary of the correlation[1] between variations in percent household firearm ownership and variations in assault firearm death rate/law enforcement incidents involving a firearm death rate for different demographic groups by Census Division and year

Breakdown of Data Examined	Household Firearm Ownership Model I vs Assault Firearm Death Rate (# obs)	Household Firearm Ownership Model II vs Assault Firearm Death Rate (# obs)	Household Firearm Ownership Model I vs Law Enforcement Incidents Involving a Firearm Death Rate (# obs)	Household Firearm Ownership Model II vs Law Enforcement Incidents Involving a Firearm Death Rate (# obs)
Gender				
Males	Rho = 0.788 95% CI = 0.716 to 0.843 (n = 144)	Rho = 0.775 95% CI = 0.7 to 0.833 (n = 144)	Rho = 0.067 95% CI = -0.107 to 0.237 (n = 129)	Rho = 0.093 95% CI = -0.081 to 0.261 (n = 129)
Females	Rho = 0.936 95% CI = 0.912 to 0.954 (n = 144)	Rho = 0.946 95% CI = 0.925 to 0.961 (n = 144)	Not Enough Data	Not Enough Data
Race				
Hispanic or Latino	Rho = 0.229 95% CI = 0.068 to 0.378 (n = 144)	Rho = 0.373 95% CI = 0.218 to 0.51 (n = 135)	Rho = 0.026 95% CI = -0.315 to 0.361 (n = 34)	Rho = 0.168 95% CI = -0.180 to 0.479 (n = 34)
Black or African American	Rho = 0.0451 95% CI = -0.119 to 0.207 (n = 144)	Rho = -0.012 95% CI = -0.179 to 0.156 (n = 138)	Rho = -0.372 95% CI = -0.570 to -0.132 (n = 61)	Rho = -0.367 95% CI = -0.567 to -0.127 (n = 61)
White	Rho = 0.91 95% CI = 0.877 to	Rho = 0.924 95% CI = 0.896 to	Rho = 0.0894 95% CI = -0.102 to	Rho = 0.16 95% CI = -0.031 to

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	0.934 (n = 144)	0.945 (n = 144)	0.275 (n = 107)	0.339 (n = 107)
Asian or Pacific Islander	Rho = 0.691 95% CI = 0.56 to 0.788 (n = 85)	Rho = 0.661 95% CI = 0.504 to 0.775 (n = 70)	Not Enough Data	Not Enough Data
American Indian or Alaska Native	Rho = -0.006 95% CI = -0.246 to 0.234 (n = 67)	Rho = 0.0749 95% CI = -0.187 to 0.327 (n = 58)	Not Enough Data	Not Enough Data
2006 Urbanization				
Large Central Metro	Rho = 0.568 95% CI = 0.446 to 0.669 (n= 144)	Rho = 0.468 95% CI = 0.329 to 0.586 (n = 144)	Rho = 0.128 95% CI = -0.085 to 0.329 (n = 87)	Rho = 0.229 95% CI = 0.019 to 0.419 (n = 87)
Large Fringe Metro	Rho = 0.618 95% CI = 0.506 to 0.710 (n = 144)	Rho = 0.649 95% CI = 0.543 to 0.734 (n = 144)	Rho = -0.324 95% CI = -0.593 to 0.011 (n = 35)	Rho = -0.204 95% CI = -0.503 to 0.139 (n = 35)
Medium Metro & Small Metro	Rho = 0.757 95% CI = 0.677 to 0.819 (n = 144)	Rho = 0.758 95% CI = 0.678 to 0.82 (n = 144)	Rho = -0.181 95% CI = -0.393 to 0.05 (n = 74)	Rho = -0.218 95% CI = -0.425 to 0.011 (n = 74)
Micropolitan & Noncore (non-metro)	Rho = 0.831 95% CI = 0.772 to 0.876	Rho = 0.784 95% CI = 0.711 to 0.840	Rho = -0.214 95% CI = -0.568 to 0.207	Rho = -0.175 95% CI = -0.540 to 0.246

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(n = 141)	(n = 141)	(n = 24)	(n = 24)

[1] The Spearman's rank correlation statistic was employed.

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