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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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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 >31,000 deaths and 74,000 nonfatal injuries resulting from firearms each year. This longitudinal ecological study analyzed variations in 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 to 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.

1. 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 and Hemenway, 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 > 31,000 deaths and 74,000 nonfatal injuries annually (Siegel et al., 2013). Firearms in the US cause >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.

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

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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 to 2014. This study also examined potential correlations between differences in HFO rates and 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.

2. Methods

Geographic and demographic variables were hypothesized to significantly impact 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.

2.1. 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 to 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 subnational 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.

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 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.

2.2. 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).

2.3. 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 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.

3. 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 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 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