

**ASSAULT OF LAW ENFORCEMENT OFFICERS IN THE LINE-OF-DUTY:
SITUATIONAL AND POLICY CONTEXTS**

by

Cassandra Kercher Crifasi, MPH

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Abstract

Law enforcement is an occupation with inherent risks. Law Enforcement Officers (LEOs) face physical and psychological challenges while responding to scenes, pursuing and arresting suspects, and managing hostile situations to keep their communities safe. Despite decreases in overall workplace homicides over the past several decades in the United States, LEOs continue to experience one of the highest rates of occupational homicide. Since fatal assaults are only a small, albeit important, piece of the picture when looking at occupational safety among LEOs, this dissertation explores the context of nonfatal assaults and makes comparisons between fatal and nonfatal LEO assaults to understand similarities and differences between these assault outcomes.

This dissertation is divided into three manuscripts. Manuscript one compares the rates, trends, and situational contexts of fatal and nonfatal LEO assaults. Firearm use by suspects/criminals represents a significant occupational hazard for LEOs. Manuscript two examines the role of firearms in assaults and circumvention of LEO body armor. Rifles were responsible for most threshold exceeding vest penetrations resulting in injury. Manuscript three evaluated the impact of changes to state-level crime and firearm policies on fatal and nonfatal assaults of LEOs. Three strikes laws were associated with an increased risk of fatal assault. Missouri's 2007 repeal of its permit-to-purchase handgun licensing law was associated with increased risk of nonfatal assaults with handguns.

Law enforcement agencies and/or local level governments should consider establishing mandatory wear policies for body armor use to improve LEO safety. This armor should be engineered for comfort while providing protection against the types of

firearms being used against LEOs. Handguns remain the most common type of firearm used in LEO assaults. State legislators wanting to address the lack of federal legislation mandating background checks for all sales could consider permit-to-purchase handgun licensing laws.

Future research on LEO occupational safety should explore if and how situational factors independently predict fatal outcomes to better inform departmental policies. Other state and local policies, such as hot spots policing or focused deterrence should be evaluated for an impact on LEO safety and consider associations with both fatal and nonfatal LEO assaults.

Advisor: Daniel W. Webster, ScD, MPH

Readers: Keshia M. Pollack, PhD, MPH
Jacqueline Agnew, PhD
David M. Bishai, MD

Alternates: Emma E. McGinty, PhD, MS
Sheldon Greenburg, PhD

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Chapter One: Introduction

Rationale for Research

Law Enforcement as an Occupation

According to the Federal Bureau of Investigation (FBI), there are currently more than 650,000 full-time law enforcement officers (LEOs) in the United States.¹ Most LEOs have full arrest authority, are paid from a governmental fund specific to law enforcement, usually carry a badge and a department issued firearm,² and include state and local LEOs working for a variety of departments and agencies.³

The first shift toward the type of law enforcement that we see today began in Philadelphia in 1833;⁴ this was the start of organized patrols by uniformed officers. Since the mid-nineteenth century, the duties of law enforcement have expanded and changed. While law enforcement started out as volunteers keeping night watch, it has become a full time occupation with a highly trained workforce.⁴

LEOs may patrol on foot or bicycles, but are more regularly seen on patrol in vehicles or on motorcycles to better pursue suspects. Depending on the region or shift, LEOs may be working alone or with a partner.⁴ LEOs exert themselves physically while running various distances, and climbing over and jumping off objects.^{4,5} LEOs must handle dangerous suspects and often wear heavy, protective body armor that may hamper mobility⁶ while initiating traffic stops, investigating crimes, and exercising warrants among others duties to protect their communities.^{4,5}

LEOs face myriad job demands that place them under physical and psychological stress on a regular basis. Law enforcement is also an occupation that is unique in its interactions with the public. Fridell identified seven of the ten National Institute for Occupational Safety and Health's risk factors for workplace violence as being pertinent

for law enforcement: contact with public; a mobile work place; working with unstable or volatile people; working alone or in small numbers; working late at night or during early morning hours; working in high crime areas; and working in community based settings.⁷ Occupations with a high frequency of public contact have been shown to have the highest risk of homicide.⁸⁻¹⁰

LEOs face these risks not only while on-duty. A survey of LEOs found that nearly all (96%) reported taking an off-duty shift as security for a private employer at some point during their career, and 15% reported regularly working off-duty security to supplement their standard pay.¹¹ Having an additional security job increases the time that LEOs are exposed to risk factors for violence.

Due to the risk of violence and fatal assault, LEOs also experience high levels of stress and other health issues, such as cardiovascular disease and depression.¹²⁻¹⁵ LEOs deal with a number of psychological stressors ranging from shift work to the shooting of suspects and on-the-job deaths of colleagues.^{4,16-18} All of these factors contribute to increased stress levels among LEOs that may impact their ability to perform job duties.^{19,20} Increases in perceived stress have been linked to anxiety, depression, burnout, and post traumatic stress disorder.^{14,15} Social support systems are important for LEOs. This support can help reduce the negative impacts of on-duty stressors.

Patterns in Fatal and Nonfatal Assaults

While performing their duties, LEOs frequently experience unintentional injuries including sprains, strains, and contusions.²¹ LEOs also have a fatal occupational injury rate that is as much as five times higher than the national average of private sector

workers.^{5,22} Despite the fact that some of these fatalities are unintentional (e.g. motor vehicle collisions), a significant portion are the result of assault and homicide.²³

Nationally, both general population homicide and LEO homicide are on the decline; however the LEO homicide rate has consistently been higher than the rate of the general population.^{8,10} In 1981 the LEO homicide rate more than twice that of the general population (20.8/100,000 versus 9.8/100,000).^{8,24,25} As of 2011, the LEO homicide rate was still nearly double the general population rate at 8/100,000,²⁶ compared to 4.7/100,000 in the general population.²⁴ Currently, the only occupation with a homicide rate greater than that of law enforcement is taxi drivers (8/100,000 and 10.4/100,000, respectively).^{7,27} In 1996, there were 12.5 nonfatal assaults per 100 LEOs, with about one quarter resulting in some form of injury.²⁸ As of 2011, the rate of nonfatal assaults has dropped to 10.2 per 100 LEOs.²⁶ The number of assaults resulting in injury remained stable.

Firearms as an Occupational Hazard

While the LEO homicide rate is on the decline,^{8,29} firearms remain the leading weapon used by suspects in assaults against LEOs.³⁰ The percentage varies over time, but firearms consistently account for 75% to 95% of weapons used in LEO homicides in a given year.^{5,8,10,31-34} It is estimated that 4.5 million new firearms are sold in the U.S. each year; half of which are handguns.³⁵ Among the firearms used, handguns are the most common type of firearm used to commit LEO homicides.^{30,33} Handgun caliber used in fatal LEO assaults has been previously examined – the most common handgun used in fatal assaults during the 1980s was a .32 caliber and carried nearly 17 times greater risk of use in a fatal assault compared to other firearms.³⁶ While LEOs may encounter long

guns (i.e. rifles and shotguns) while responding to homes, particularly in rural areas, long guns are not traditionally thought of as representing as large an occupational risk among law enforcement as they more often encounter handguns during assaults.³⁷

The Impact of Changing Policy Environments

The environments in which LEOs work are likely to be affected by the policies of their given state. Right-to-carry (RTC) concealed weapons laws, three strikes laws, and permit-to-purchase (PTP) handgun laws are examples of the types of laws that could influence LEO safety. RTC laws have been evaluated for impacts among the general population and law enforcement. There have been studies showing protective effects of RTC laws against homicides of LEOs – states with RTC laws had lower rates of LEO homicide;³⁸ however, other studies have also found no association.^{39,40} Three strikes laws have been found to increase the risk of fatal LEO assault.⁴⁰ PTP laws have been evaluated in the general population. The findings of a policy evaluation of Missouri’s 2007 repeal of its PTP law indicated that handgun homicides increased following the repeal.⁴¹

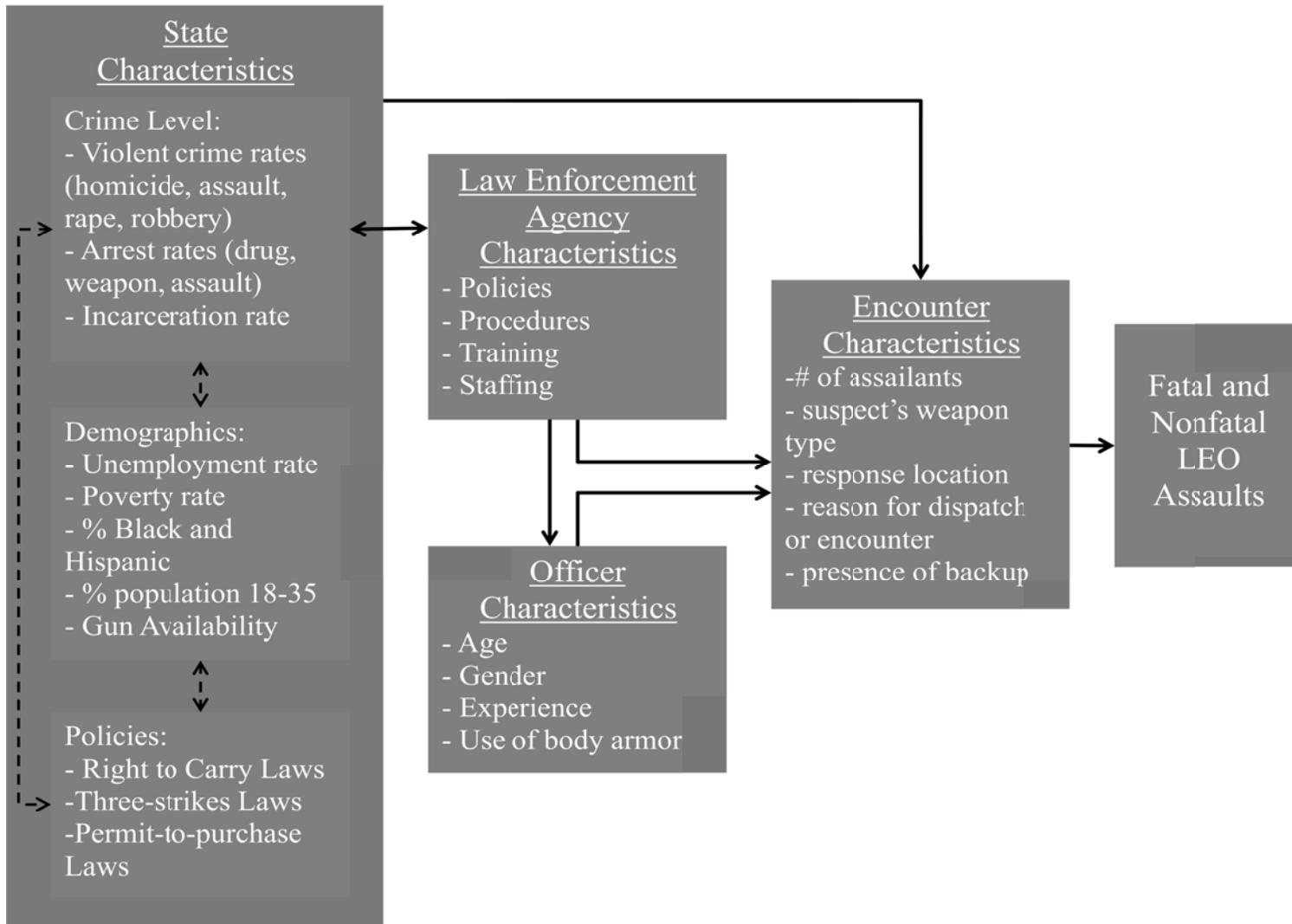
Conceptual Model

This dissertation was guided by two conceptual models that were combined and adapted. This first is the National Institute for Occupational Safety and Health’s (NIOSH) and National Occupational Research Agenda (NORA) model of the pathways between workplace organization and illness and injury. This model was developed to demonstrate the interplay of workplace health and safety programs and exposures to psychological stressors and physical hazards.⁴² The interactions of these factors then determine whether a workplace injury (and/or illness) occurs. This model has been used to assess the impact workplace violence in the healthcare setting,⁴³ and, according to the most recent version

of the NORA, this model has served as a guide for a variety of occupational safety and health research topics including musculoskeletal injuries.⁴⁴ The NIOSH/NORA model offers a good starting point, but fails to consider additional factors such as individual employee characteristics, the work environment at the time of the injury, and other workplace or policy factors that may contribute to whether an injury occurs.

For that reason, the NIOSH/NORA model was combined with the Socioecologic model,⁴⁵ which allows for the incorporation of various levels of influence for a better depiction of interactions and pathways. This model has been used to assess behavior change and health promotion,^{46,47} and has also been previously applied in violence research.⁴⁸ The model for this dissertation was also supplemented by current literature to capture all of the potential factors involved. This model conceptualized the factors and contexts leading to fatal and nonfatal assaults of LEOs. All of the characteristics in the model were mediated through a LEO's encounter with a suspect since this interaction immediately precipitates the occurrence of both fatal and nonfatal assaults. The two outcomes were grouped together to assess whether the same pathways exist regardless of whether an assault results in a fatality.

Conceptual Model for Dissertation Research



This adapted conceptual model aided in the identification of existing research gaps and formulation of specific aims. This dissertation fills gaps in the current literature to answer three key research questions.

(1) What similarities and differences exist in the contexts of fatal and nonfatal assaults? The contexts and factors influencing fatal LEO assaults have been well studied using various time periods, methodologies, and data sources. However, the same is not true for nonfatal assaults. It is unknown if similar factors influence assaults regardless of outcome or if nonfatal assaults can be thought of as “near-miss” homicides. If there are similar contexts then policies and procedures to address fatal assaults may also help to reduce the occurrence of nonfatal assaults.

(2) What role do specific firearm types have in LEO assault and circumvention of body armor? The role of firearms and their use in fatal assaults has been documented. However, as with the general context of nonfatal assaults, what role firearms play in nonfatal assaults is unclear. Though research has demonstrated the value and lives saved as a result of body armor use, there is a gap in the literature related to the circumvention of body armor – which types of firearms are responsible, how often body armor is circumvented, and the outcomes of circumvention.

(3) What impact do RTC laws, three strikes laws, and PTP laws have on LEO safety? There is mixed evidence on the impact of RTC laws on fatal assaults, and indications that in states with three strikes laws there is increased risk of fatal LEO assault. The understanding of how these policy influence nonfatal assaults is missing. Missouri’s PTP repeal in 2007 was associated with increased risk of general population homicide. It is unknown what, if any, impact this repeal had on LEO safety. If fatal and

nonfatal assaults share similar contexts, then policies that impact fatal assaults may also influence nonfatal assaults. Identifying potential associations will provide a better understanding of how state-level policy changes affect LEO safety.

Overall, this dissertation attempts to fill the gaps in understanding related to nonfatal LEO assaults. The fatal LEO assault rate has been on the decline, but there is still more that can be done. Identifying similar factors between fatal and nonfatal assaults will inform the modification or development of policies and procedures designed to improve LEO occupational safety. This dissertation also identifies potential areas of improvement in the data source that would enhance researchers' ability to study and improve LEO safety.

Study Aims

This dissertation has three aims and associated hypotheses:

1. To describe the situational contexts in which law enforcement officers are assaulted and compare these contexts between fatal and nonfatal assaults.
2. To describe and evaluate the role of suspects' firearm use in assaults of law enforcement officers and circumvention of body armor.
 - a. Hypothesis 2: large caliber/high velocity firearms will be associated with greater risk of body armor circumvention
3. To evaluate the impact of state-level policy changes on fatal and nonfatal assault of law enforcement officers.
 - a. Hypothesis 3a: right-to-carry laws will not be significantly associated with LEOs assaults

- b. Hypothesis 3b: three strikes laws will be significantly positively associated with fatal LEO assaults
- c. Hypothesis 3c: Missouri's permit-to-purchase handgun licensing law repeal will be significantly positively associated with LEO assaults

Dissertation Organizations

Chapters 2-4 of this dissertation contain the three manuscripts and Chapter 5 is a concluding chapter. Manuscript one is a descriptive epidemiologic study that compares rates, trends, and situational contexts of fatal and nonfatal LEO assault. Manuscript two describes the role of firearms in fatal and nonfatal LEO assaults and evaluates factors related to circumvention of LEO body armor. Manuscript three is an evaluation of the impact that changing state-level crime and firearm policies have on fatal and nonfatal assaults over time. The concluding chapter contains a summary of findings from the dissertation, discussion of policy implications, and areas of research that should be prioritized.

Tables and figures are embedded in the text of each manuscript, as near to the relevant text as possible. Supplemental tables that are discussed but not presented within the text of a manuscript are located in the appendices.

Chapter Two: Manuscript One

Assaults of Law Enforcement Officers in the Line-of-Duty

Cassandra Kercher Crifasi

Johns Hopkins Bloomberg School of Public Health

Department of Health Policy and Management

Abstract

Objective: To describe the situational contexts in which law enforcement officers (LEOs) are assaulted and compare these contexts between fatal and nonfatal assaults in the United States

Methods: This is a descriptive epidemiologic study using data from the Law Enforcement Officers Killed and Assaulted database. Rates, trends, and case fatality rates (CFR) were generated to describe fatal and nonfatal assaults. Comparisons were made between fatal and nonfatal assaults to gain an understanding of risks and hazards faced by LEOs assaulted in the line-of-duty.

Results: Between 2002 and 2011, there were 523 fatal assaults and 1,257 nonfatal assaults of LEOs. The overall CFR for assaults and the firearm-specific CFR have increased overtime. More than half of assaulted LEOs were on a one-officer vehicle assignment when they were assaulted. Compared with LEOs who suffered nonfatal assaults, a higher proportion of fatally assaulted LEOs were ambushed, experienced an unprovoked attack, or conducting traffic stops. A higher proportion of nonfatally assaulted LEOs were conducting investigations or attempting arrest when they were assaulted.

Conclusions: Firearm use by suspects continues to represent a significant occupational hazard to law enforcement. Policies that restrict access to firearms by criminals or otherwise deter criminal use of firearms could increase LEO safety. Jurisdictions should consider requiring LEOs to wear armor at all times while on duty and partnering LEOs to provide backup.

Introduction

Law enforcement officers (LEOs) have a fatal occupational injury rate that is as much as five times higher than the national average of private sector workers.^{5,22} While some of these fatalities are unintentional (e.g. motor vehicle collisions), a significant portion are the result of assault and homicide.²³ LEOs place themselves at risk daily while ensuring the safety of their communities. LEOs face these risks while initiating traffic stops, investigating crimes, and interacting with potentially dangerous suspects.^{4,5} The characteristics of law enforcement as an occupation increase the likelihood of interaction with the public and thereby increases the risk of assault.¹⁰ Seven of the ten National Institute for Occupational Safety and Health's risk factors for workplace violence have been identified as pertinent for law enforcement: contact with public; mobile work place; working with unstable or volatile people; working alone or in small numbers; working late at night or during early morning hours; working in high crime areas; and working in community based settings.⁷

The rate of LEO homicide has been on the decline; however there are a number of factors that lead to increased risk of assault among LEOs. Areas with higher rates of crime^{9,49,50} and arrest⁵¹ also see higher rates of LEO assault, which may be due to increased exposure to potential acts of violence while responding to calls and arresting suspects. Poverty is also positively associated with risk of fatal LEO assault,³² possibly due to concentrated disadvantage and higher crime.

The LEO homicide rate has consistently been higher than the rate of the general population.^{8,10} Currently, the only group with an occupational homicide rate greater than that of law enforcement is taxi drivers (8/100,000 and 10.4/100,000, respectively).^{7,27}

Since the 1980s, the most common weapon used to kill a LEO has been a firearm. The percentage varies over time, but firearms consistently account for between 75% and 95% of the weapons used in LEO homicides.^{5,8,10,31,32,34,52} One of the biggest differences between fatal and nonfatal injuries is thought to be the weapon used by the suspect, owing to the lethality of firearms, and location of the wound.⁷ This study explores this potential relationship and adds support for the theory.

Previous research has explored the reasons why suspects kill LEOs. These fatal assaults of LEOs are contextual and situational, and often occur during the suspects' efforts to escape after committing a crime.³¹ This is consistent with previous research indicating that many fatal and nonfatal LEO assaults occur during arrest situations and disturbance calls;^{10,52} LEOs interact with a suspect during or shortly after the commission of a crime and these suspects attempt to evade capture by assaulting a LEO.

The term body armor may bring to mind a wide array of protective equipment, but in the majority of instances body armor is specifically referring to ballistic or bulletproof vests. Even as the number of LEOs and rates of violent crime increased, there has been a decline in LEO homicide since the mid-1970s. Body armor is thought to be the most important factor in this decline, though it can be challenging to directly estimate benefits since the actual number of LEOs wearing body armor is unknown.²³ The FBI and National Institute of Justice, using a case-control design, found that LEOs not wearing armor were at 14 times greater risk of fatal injury,⁵³ though these were not restricted to torso wounds. These findings were used to estimate that between 1973 and 2001 body armor has prevented nearly 1,500 LEO homicides.^{32,53,54} This research suggests that, without the use of body armor, the fatal assault rate over the past four decades could have

been twice as high. The percent of LEOs working for a department that requires body armor use at least some of the time has increased from 30% in the 1990s to eighty percent as of 2010.³⁴

The purpose of this study is to describe the contexts in which LEOs are assaulted and compare these between fatal and nonfatal assaults. Understanding the factors that influence both fatal and nonfatal assaults will offer better insight into the occupational safety risks LEOs face. Recognizing potential shared factors and identifying unique assault characteristics are important for the development of policies and technologies to keep LEOs safe.

Methods

This is a descriptive epidemiologic study to describe the distribution of assaults and assault characteristics among LEOs.⁵⁵ Data for this study came from the Federal Bureau of Investigation's (FBI) Law Enforcement Officers Killed and Assaulted (LEOKA) database.⁵⁶ The FBI generates this database from reports of every line-of-duty fatal assault and nonfatal assaults committed with a firearm or knife/cutting instrument that result in an injury as part of the Uniform Crime Reporting program.² The database contains a number of variables for each assault including those relevant to this study: suspects' weapon type, LEO assignment (e.g. one-office vehicle), encounter (e.g. traffic stop), location of the primary wound, and whether the LEO was wearing body armor when assaulted. Data for this study spans 1980-2011 for fatal assaults and 2002-2011 for nonfatal assaults. The FBI did not begin collecting data on nonfatal assaults until 2002.

To generate rates of fatal and nonfatal assaults, counts were taken from the LEOKA database as the numerator. The denominator, the number of LEOs in the U.S., came from the number of LEOs reported to the UCR in each state,²⁶ which represents the best estimate of the number of LEOs in the U.S. Descriptive statistics were used to describe differences in fatal and nonfatal assaults for encounter, assignment, primary wound location, use of body armor, and suspects' weapon use.

The overall case fatality rate (CFR) was calculated, as well as weapon specific CFRs, to illustrate changes in fatal compared to nonfatal assaults. The CFR represents the number of LEOs dying from an assault divided by the number of LEOs experiencing an assault.⁵⁷ The CFR is being used as a measure of assault severity in addition to overall rates of fatal and nonfatal assault. When making direct comparisons (i.e., case fatality rates, encounter, assignment, and wound location), fatal assault data were restricted to the period of available data for nonfatal assaults, 2002-2011. Where appropriate, all available fatal assault data were used to demonstrate changing trends in fatal assaults (i.e., assault rates, prevalence of firearm use by suspects, and body armor use by LEOs). Analyses were conducted using Stata IC v 11.2.⁵⁸ This study was deemed to be “not human subjects” research by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Results

Between 2002 and 2011, there were 523 fatal assaults and 1,257 nonfatal assaults of LEOs in the U.S. On average, LEOs that were fatally assaulted were slightly older and more experienced, but were similarly comprised by gender and race (Table 2.1). The

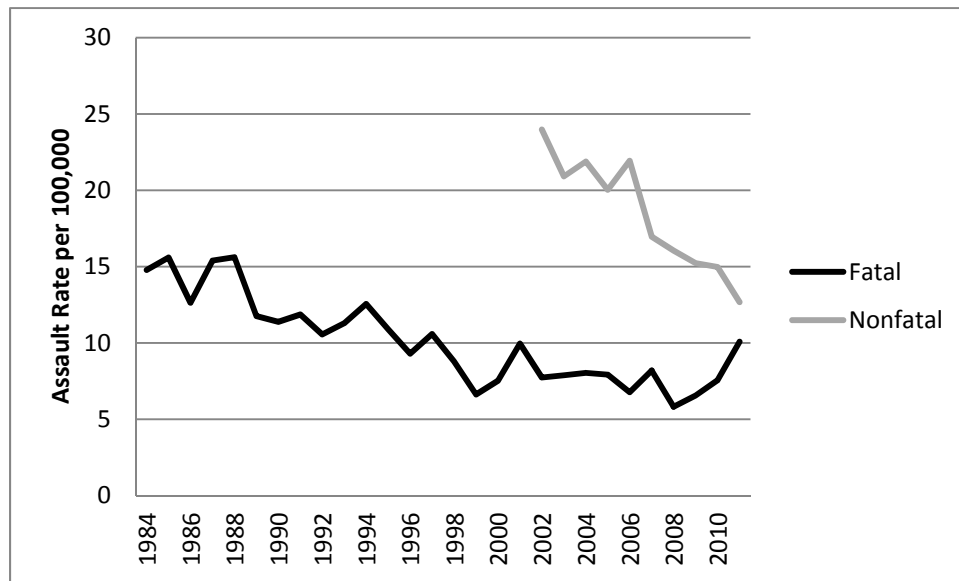
rates of both fatal and nonfatal assaults have been on the decline, but nonfatal assaults decreased more rapidly from 2002 to 2011 (Figure 2.1). Fatal assaults were more likely to have been committed with a firearm than were nonfatal assaults, with use ranging from 85% to 99% for fatal assaults and 60% to 75% for nonfatal assaults (Figure 2.2).

Table 2.1: Descriptive Statistics Comparing Fatal and Nonfatal LEO Assaults, 2002 – 2011

Characteristic	Fatal (N = 523)	Nonfatal (N = 1257)
Mean Age in years	38	35.8
Average experience (months)	128.7	119.7
Male (%)	95	95
White (%)	85	87
<i>Firearm (%)</i>	<i>92</i>	<i>66</i>
Handgun	67	49
Rifle	18	9
Shotgun	7	7

The overall CFR, as well as those for firearm and knife assaults, are shown in Figure 2.3. The CFR for knife assaults was fairly stable averaging nearly 0% across the study period, while both the overall and firearm specific CFRs increased. The overall CFR for LEO assaults increased between 2002 and 2011. This increase was largely driven by the increase in the firearm specific CFR during that time. When considering CFR for different firearm types, there is variation in the CFRs for both shotguns and rifles, while the CFR for handguns looks fairly similar to that of the overall CFR (Supplemental Figure 2.1).

Figure 2.1: Rates of Fatal and Nonfatal Law Enforcement Officer Assaults, 1984 – 2011



For the type of assignment a LEO was on when assaulted, there were no apparent differences between fatal and nonfatal assaults. The vast majority of assaulted LEOs were on one-officer vehicle assignments (Figure 2.4). There were a number of differences in the type of encounter or response call between fatal and nonfatal assaults (Figure 2.5). A higher proportion of fatally assaulted LEOs were ambushed, experienced an unprovoked attack, or conducting traffic stops at the time of the assault. A higher proportion of nonfatally assaulted LEOs were conducting investigations or attempting arrest.

Figure 2.2: Prevalence of Firearms Used by Suspects in Fatal and Nonfatal Law Enforcement Officer Assaults, 1980 - 2011

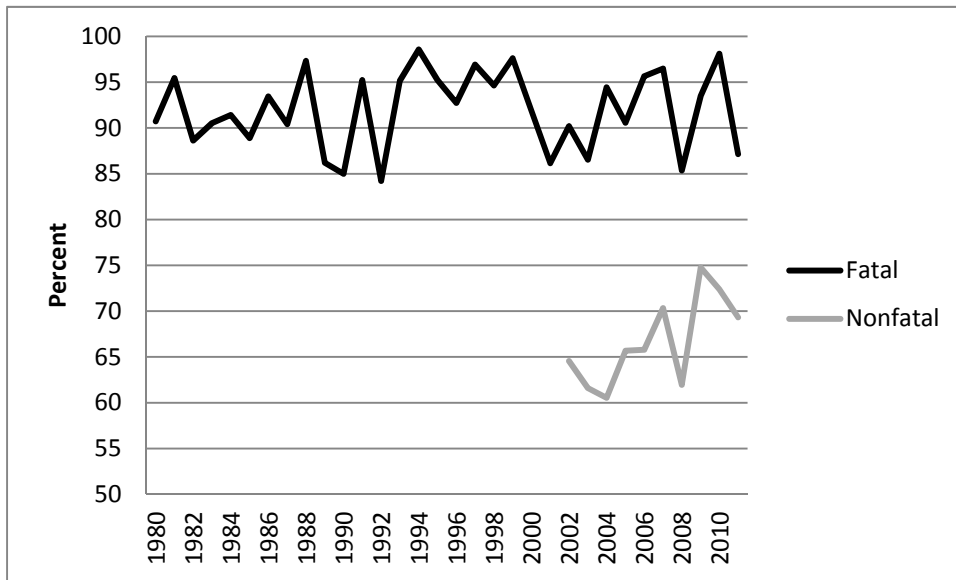


Figure 2.3: Case Fatality Rates for Law Enforcement Officer Assaults, 2002 – 2011

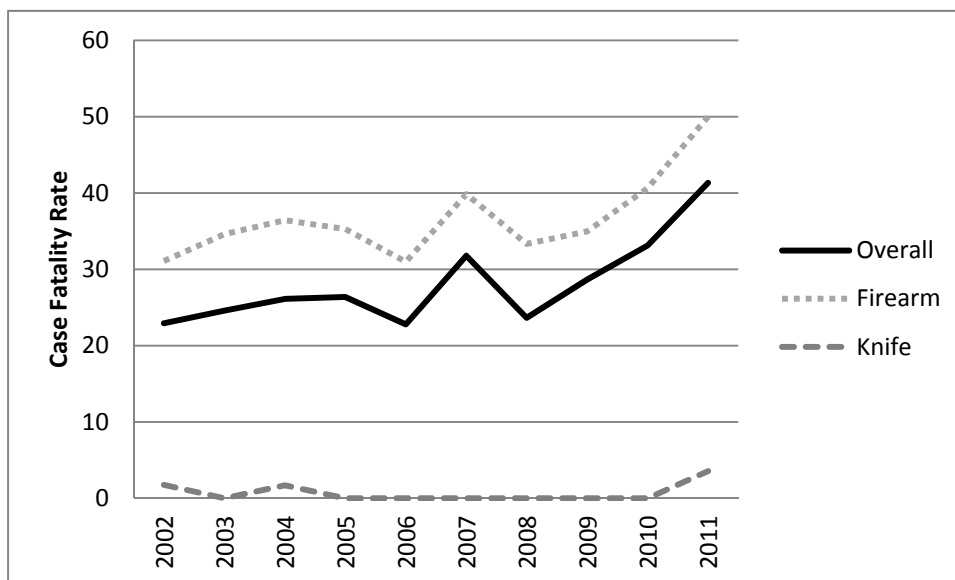


Figure 2.4: Type of Law Enforcement Officer Assignment at Time of Assault, 2002 – 2011

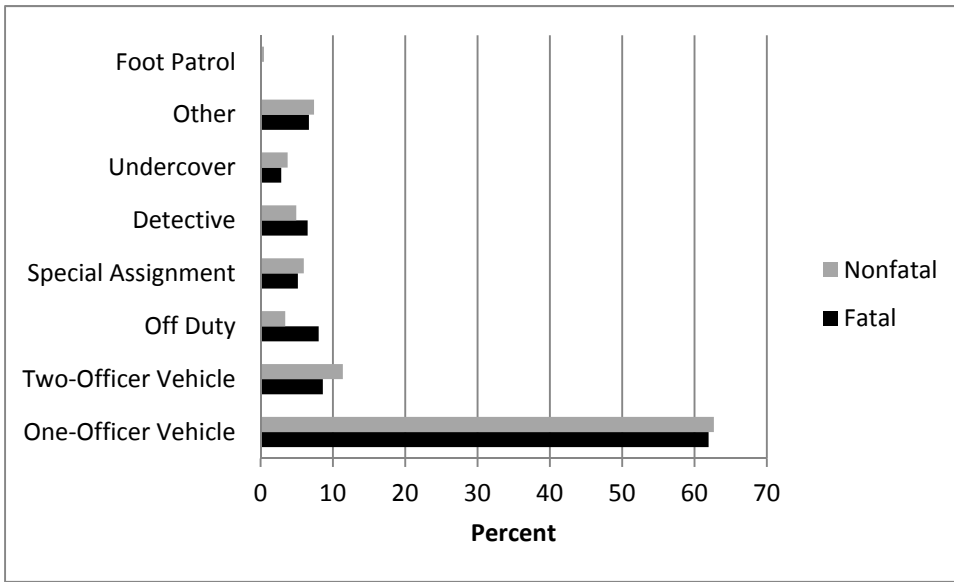
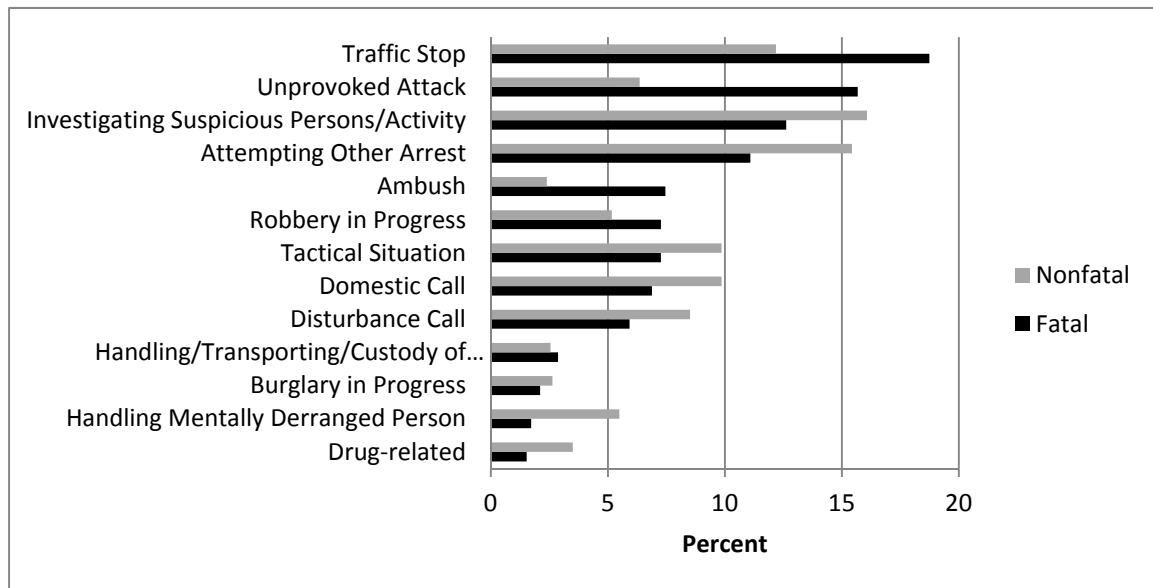


Figure 2.5: Type of Encounter/Response Call at Time of Law Enforcement Officer Assault, 2002 – 2011



A major difference between fatal and nonfatal assaults was the location of the primary wound (Figure 2.6). For fatal assaults, nearly 60% of primary wounds were received to the head or neck/throat, while nearly 65% of nonfatal primary wounds were received to the arms/hands or below the waist. In 1980 only 14% of fatally assaulted LEOs were wearing body armor at the time of the assault, which increased to nearly 80%

in 2011. For nonfatally assaulted LEOs, 73% were wearing body armor at the time of the assault in 2002, which increased to nearly 90% in 2011 (Figure 2.7).

Figure 2.6: Primary Wound Location for Assaulted Law Enforcement Officers, 2002 – 2011

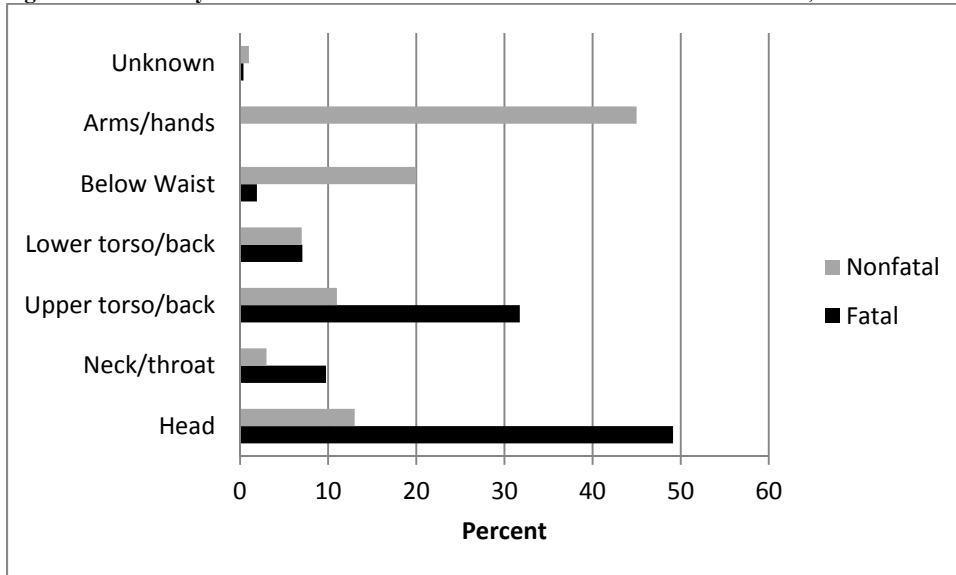
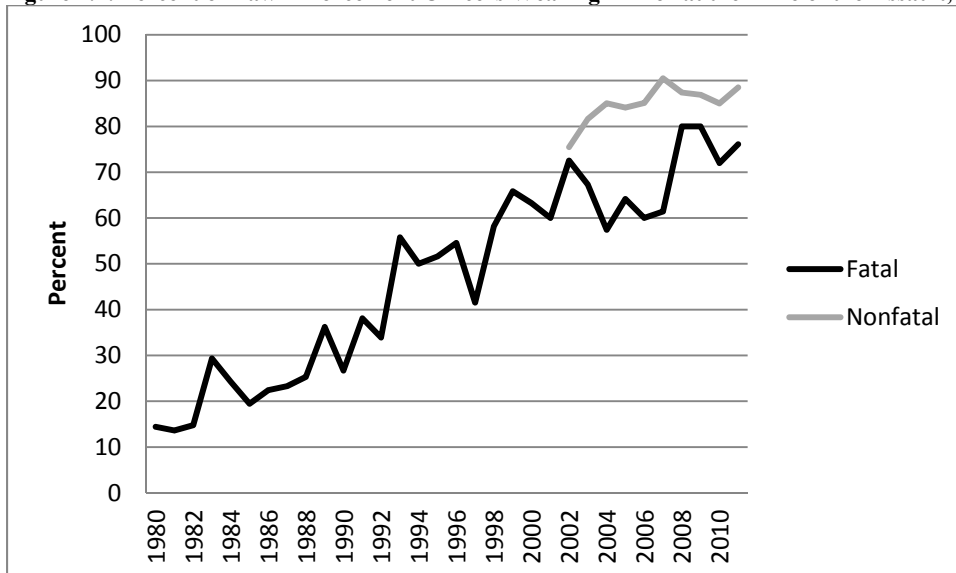


Figure 2.7: Percent of Law Enforcement Officers Wearing Armor at the Time of the Assault, 1980 – 2011



Discussion

There have been a number of studies describing circumstances of LEO homicides, but very few have focused on nonfatal assaults. When one considers the burden of

injuries in a population, fatalities are only the tip of the iceberg. For each fatality, there are many more nonfatal injuries. Understanding the similarities and differences between fatal and nonfatal LEO assaults are important to creating a clear and complete picture of factors influencing LEO safety and the determinants of lethal outcomes.

While the rates of nonfatal assaults have been on a steady decline, the decline in fatal assaults has halted and potentially even reversed. This has alarming implications. The increasing case fatality rate illustrates that, even though overall there are fewer LEOs being assaulted, a higher percentage of these assaults are resulting in fatalities despite increased use of body armor by LEOs. An important area for future research is an evaluation of the relationship between the situational factors explored here and their independent effects on lethal outcomes.

There has been some variation, but very little reduction in the use of firearms by suspects assaulting LEOs over the study period. Between 2002 and 2011 there were a total of 428 knife assaults (24% of all assaults), but only two resulted in a fatality. This makes sense when one considers the proximity required to commit a homicide with a knife, in conjunction with the training LEOs receive and the use of body armor – 80% of LEOs experiencing a nonfatal knife assault were wearing body armor at the time, which could reduce the effectiveness of a knife in a LEO assault and decrease the risk of a fatality.

It has been estimated that if a LEO is not wearing body armor and is shot in the torso, he/she is three times more likely to die than a LEO wearing armor; 8.6 lives per year could be saved if LEOs were required to wear body armor at all times while working.³⁴ The findings in this study indicate that the odds of a LEO dying of a wound to

the upper torso or back while not wearing armor may be as much as 7.9 times higher than a LEO wearing armor.

Some differences remain in body armor use at the time of an assault between those that result in a fatal versus nonfatal injury. However, there has been a consistent increasing trend in body armor use among fatally assaulted LEOs. A lack of body armor use among those fatally assaulted does not fully answer differences between fatal and nonfatal assaults. While body armor does have the potential to reduce rates of LEO homicide, it is also not the only solution.

The case fatality rate is increasing for LEO assaults which is being driven by firearm homicides despite the increasing use of body armor among LEOs. This could be due to high velocity firearms such as large caliber handguns or rifles that have the potential to circumvent body armor. Additionally, the majority of fatal wounds were sustained to parts of the body not protected even if a LEO was wearing body armor when assaulted. Body armor may help improve LEO safety, but an important issue here is limiting access to and use of firearms by criminals.

More than 60% of LEOs experiencing either a fatal or nonfatal assault were on a one-officer vehicle assignment. This does not necessarily mean they were alone at the time of the assault as they could have called for backup, but LEOs that were assaulted were more likely to be working without a partner than with a partner. This has implications for staffing and responding to calls for service. Having a partner may allow the LEOs to watch each other's backs. This has the potential to reduce the severity of an assault, or deter an assault entirely, by having a second LEO responding to a call. Having a partner could also reduce situations where a LEO is ambushed or an unprovoked attack

occurs since LEOs would be able to look out for one another. Not all jurisdictions will have the resources to partner every LEO. In these instances it would be important to have established dispatch protocols, particularly for calls that may be more likely to result in an assault, such as traffic stops.

Both ambush and unprovoked attacks are encounters that were more than twice as prevalent in fatal assaults compared to nonfatal assaults. It is likely that in these types of encounters LEOs may be caught off guard or have little time to respond or defend themselves, leading to ambush and unprovoked attacks being more prevalent among fatally assaulted LEOs. LEOs are a visible “arm of the law” present in both urban and rural communities. It is possible that anti-social or anti-government attitudes may be a driving factor increasing ambush and unprovoked attacks during which LEOs have limited opportunity for defense. While this study is unable to address the question of what is driving increases in fatal ambush and unprovoked attacks, it does present an interesting and urgent priority for future research.

There are a few limitations in this study related to the data source. The FBI has a strict definition of line-of-duty homicides. LEOs must be on-duty at the time of the assault, or off-duty but performing actions as though on-duty such. This definition has the potential to miss or undercount fatal assaults⁵⁹ and potentially nonfatal assaults. The database also only collects information on nonfatal assaults committed with a firearm or knife/cutting instrument that results in an injury. There are likely to be assaults committed with other weapons (e.g. blunt objects or fists) that result in injury. However, nonfatal assaults with a firearm or knife are likely to be more similar to fatal assaults due to potential lethality of weapons used. There is also the possibility that the reporting of

nonfatal assaults is restricted to the most serious injuries. This could also make these assaults more similar to those that result in a fatality. This data only represents LEOs that were assaulted; therefore the ability to make comparisons between LEOs assaulted versus not to garner information on how often LEOs are assaulted responding to specific types of calls or types of assignments is lacking. Finally, this database was not designed for research, so some variables of interest are not captured such as the type of body armor being used by LEOs.

This study also has a number of strengths. The LEOKA database provides a variety of details that are important to understanding the context of LEO assaults. The LEOKA database is the only source for details of nonfatal LEO assaults and this is the first study to our knowledge that compares the contexts of fatal and nonfatal assaults nationally. This study fills a significant gap in understanding the occupational safety of LEOs. The similarities between fatal and nonfatal assaults provide new opportunities for the evaluation of policy impacts and other factors that may influence LEO safety.

Firearms are used in the majority of assaults against LEOs.^{5,34,52} Policies that keep firearms out of the hands of criminals and prohibited persons could improve LEO safety. Additionally, policing strategies that have been shown to reduce firearm-related crime and carrying among offenders such as hot-spots policing and focused deterrence may influence LEO safety if criminals are deterred from carrying and/or using firearms while committing crimes.⁶⁰⁻⁶² An examination of the impact of these strategies on LEO safety represents an interesting area of future research.

There are a couple of steps that individual jurisdictions could take to help increase LEO safety. Jurisdictions should require LEOs to wear body armor at all times while on-

duty and new technologies are needed that can address parts of the body not covered by current armor. Jurisdictions should consider partnering their LEOs or establishing backup protocols to provide additional protection to LEOs while responding to calls and serving the community.

This study demonstrates that a number of similarities exist between fatal and nonfatal assaults with injury. These similarities indicate an opportunity to extend the evaluation of policy impacts to include nonfatal assaults and gain a greater understanding of factors influencing LEO safety in the U.S.

Chapter Three: Manuscript Two

Exceeding the Threshold: The Role of Firearms in Law Enforcement Officer Assaults
and Circumvention of Body Armor

Cassandra Kercher Crifasi

Johns Hopkins Bloomberg School of Public Health

Department of Health Policy and Management

Abstract

Objective: To describe and evaluate the role of suspects' firearm use in assaults of law enforcement officers (LEOs) and circumvention of body armor in the United States

Methods: This is a descriptive epidemiologic and retrospective case-control study using firearm specific fatal and nonfatal assault data from the Law Enforcement Officers Killed and Assaulted database. The type and caliber of firearms used in fatal and nonfatal assaults are described to better understand the role of firearms in LEO assaults. Cases were defined as assaults where the threshold of LEO body armor was exceeded, compared to controls that were also wearing armor but the threshold was not exceeded. Simple and multiple logistic regressions were used to generate odds ratios (OR) for covariates hypothesize to be related to vest penetration: distance from suspect, suspects' firearm type, and handgun caliber.

Results: 1980 to 2011 there were 1,825 fatal assaults and 2002 to 2011 there were 833 nonfatal LEO assaults committed with a firearm. Handguns were used in 74% of both fatal and nonfatal firearm assaults. There were 87 threshold exceeding vest penetrations: 73% resulted in a fatality; 66% occurred since 2002; and 79% were committed with a rifle. Being shot with a rifle increased the odds of having a threshold exceeding vest penetration by 53 times ($p < 0.001$) after controlling for distance from suspect.

Conclusions: Firearms represent a significant occupational hazard for LEOs. Handguns remain responsible for the vast majority of assaults; however, rifles are associated with increased risk of injury among LEOs wearing armor that should protect them from injury.

Introduction

Law enforcement officers (LEO) have a fatal occupational injury rate that is as much as five times higher than the national average of private sector workers.^{5,22} A significant portion of these deaths are due to assault and homicide.²³ For the first time in 2011, firearm assaults replaced motor vehicle crashes to become the leading cause of all law enforcement occupational fatalities.⁶³

While the LEO homicide rate is on the decline;^{8,29} firearms remain the leading weapon used by suspects in assaults against LEOs.³⁰ The percentage varies over time, but firearms consistently account for between 75% and 95% of weapons used in LEO homicides in a given year.^{5,8,10,31-34} Among the firearms used, handguns are the most common type of firearm in LEO homicides.^{30,33} Handgun caliber used in fatal LEO assaults has been previously examined – the most common handgun used in fatal assaults during the 1980s was a .32 caliber and carried nearly 17 times greater risk of use in a fatal assault compared to other firearm types and calibers.³⁶ Long guns (i.e. rifles and shotguns) are not traditionally thought of as representing an occupational risk to law enforcement as they more often encounter handguns during assaults.³⁷

Body armor (i.e. ballistic or bulletproof vests) has been credited as one of the most important factors contributing to the decline of fatal LEO assaults since the mid-1970s by preventing LEO homicide among LEOs shot in the torso.^{23,32} However, not all jurisdictions require LEOs to wear body armor, and those that do may only require body armor use in certain situations.³ A cross-sectional study of three years of the Law Enforcement Officers Killed and Assaulted database by LaTourrette found that LEOs shot in the torso were three times more likely to survive if they were wearing body

armor.³⁴ The results of a cross-sectional study by Fridell and colleagues found a 50% increase in expected counts of LEO assaults associated with stronger policies for body armor use.⁷ Due to the cross-sectional design, it is uncertain whether the relationship is due to LEOs taking more risks while wearing body armor or to more dangerous jurisdictions being more likely to implement stronger body armor policies to protect their LEOs.

A study of LEO homicides while responding to domestic disturbance calls found that though 67% of LEOs were wearing body armor when killed, 52% received the fatal wound in an area not covered by their body armor.⁶⁴ Increased use of body armor has the demonstrated potential to save lives, but there are other important issues to also consider – characteristics of an encounter with, and weapon use by, suspects.

Firearm use by suspects with which LEOs interact represents a significant occupational hazard. This study examines if the weapon caliber used in LEO assaults has changed over time, under what circumstances firearms circumvent LEO body armor, and what factors may increase the odds of vest penetrations. The purpose of this study was to describe incidents in which LEOs were shot and examine determinants of protective vest penetration.

Methods

This is a descriptive epidemiologic and retrospective case-control study evaluating the role of firearms in fatal and nonfatal assaults of LEOs, and examines instances where LEO body armor was circumvented by suspects' firearms. Data for this study were from the Federal Bureau of Investigation's (FBI) Law Enforcement Officers

Killed and Assaulted (LEOKA) database.² This database is assembled by the FBI using reports from every line-of-duty homicide and nonfatal assaults resulting in injury that were committed with a firearm or knife/cutting instrument. These reports are collected as part of the Uniform Crime Reporting program.⁵⁶

This database contains myriad variables relevant to firearms and the circumvention of LEO body armor during an assault: suspects' firearm type (i.e. handgun, rifle shotgun); weapon caliber/cartridge; distance from the suspect; whether the LEO was wearing body armor during the assault; and if, and how, a LEO's body armor was circumvented. Data for this study span 1980-2011 for fatal assaults and 2002-2011 for nonfatal assaults. Data collection for nonfatal assaults did not begin until 2002.

This study only considered assaults committed with a firearm for two reasons. First, more than 90% of LEO homicides and more than 65% of nonfatal assaults with injury were committed with a firearm.³⁰ Second, of particular interest in this study were assaults in which the suspects' weapon circumvented LEO body armor. In only one instance across the more than 2500 assaults during the study period did a knife circumvent body armor – a nonfatal assault where the suspect's knife entered through the side panels which is an area not as well protected by body armor.

Using common methodology for classifying caliber,^{65,66} handgun caliber was broken into three categories: small, medium, and large caliber. Small caliber handguns were defined as .22, .25, and .32. Medium caliber handguns as .38, .380, and 9 mm. Large caliber handguns were defined as .357, .40, .41, .44, .45, .50, and 10 mm. Long guns were classified as either rifle or shotgun.

Descriptive analytic methods were used to explore the data and generate means and percentages⁶⁷ for the variables of interest stratified by fatal versus nonfatal assault and presented by year where appropriate.

A retrospective case-control study design^{68,69} was used to examine factors associated with the odds of LEO body armor being penetrated by a weapon that exceeded the threshold of the body armor (i.e. LEOs that should have been protected from a wound to the torso by the body armor). Cases were defined as assaults where the threshold of LEO body armor was exceeded, compared to controls that were also wearing armor but the threshold was not exceeded. Vest failure was defined as a vest penetration where the body armor the LEO was wearing should have been able to stop the bullet from penetrating the vest, but failed. Threshold exceeding vest penetrations were defined as a vest penetration where the body armor the LEO was wearing was not designed to stop a bullet from that type or caliber of firearm from penetrating the vest.

Simple logistic regression was used to calculate odds ratios (OR) for the covariates hypothesized to be related to whether a firearm exceeded the threshold of body armor: distance from the suspect, suspects' firearm type, and handgun caliber (i.e. the exposure). Multiple logistic regression was used with the covariates that were statistically significant in simple logistic regression. Associations were considered to be statistically significant at $p < 0.05$. Analyses were conducted using Stata IC v 11.2.⁵⁸ This study was deemed to be “not human subjects” research by the Johns Hopkins Bloomberg School of Public Health.

Results

Between 1980 and 2011 there were 1,825 fatal assaults and between 2002 and 2011 there were 833 nonfatal assaults of LEOs committed with a firearm. LEOs that were fatally assaulted shared similar demographic characteristics as those experiencing nonfatal assaults (Table 3.1). Among those fatally assaulted, LEOs tended to be much closer to their attacker with 53% of assaults occurring at a distance of less than 5 feet, compared to 32% of LEOs at that distance in nonfatal assaults. LEOs were wearing armor when assaulted on average only 45% of the time in fatal assaults compared to 86% of nonfatal assaults. The breakdown of firearm type is similar between fatal and nonfatal assaults with 74% of assaults committed with a handgun (Table 3.2).

Table 3.1: Descriptive Statistics for Law Enforcement Officers Assaulted with Firearms

Characteristic	Fatal (N = 1825)	Nonfatal (N = 833)
Average experience (months)	113.7	117.5
Average age (years)	36.5	35.6
Male (%)	97	96
Race (%)		
White	86	88
Black	13	9
Asian	1	2
Indian	< 1	<1

While the percent of assaults committed with a firearm has not changed much over time, the firearm assault rate has declined along with the overall assault rates (Figure 3.1) There is some variation, but no noticeable trend overtime for the percent of fatal assaults committed with handguns and shotguns. There does appear to be a slight increasing trend in the use of rifles in fatal LEO assaults (Figure 3.2). Looking specifically at handguns, there is a downward trend in the use of small caliber handguns, some variation but indications of a downward trend in the use of medium caliber

handguns, and an increasing trend in the use of large caliber handguns in fatal assaults (Figure 3.3).

Among nonfatal assaults, firearm type shows little variation over time for handguns, shotguns, or rifles (Figure 3.4). When considering handguns specifically, there is a slight decreasing trend for small caliber handguns, some variation but indications of a downward trend for medium caliber handguns after 2005, and a clear increasing trend in the use of large caliber handguns in nonfatal assaults (Figure 3.5).

Table 3.2: Encounter Characteristics for Law Enforcement Officers Assaulted with a Firearm

Variable – (%)	Fatal (N = 1825)	Nonfatal (N = 833)
Distance from suspect		
00-05 feet	53	32
06-10 feet	20	20
11-20 feet	13	24
21-50 feet	8	14
51+ feet	6	10
Body armor use by LEOs		
Yes	45	86
No	55	14
Suspect's Firearm Type		
Rifle	17	15
Shotgun	9	11
Handgun	74	74
<i>Small Caliber</i>	<i>10</i>	<i>8</i>
<i>Medium Caliber</i>	<i>39</i>	<i>35</i>
<i>Large Caliber</i>	<i>25</i>	<i>30</i>

Figure 3.1 Firearm Assault Rate per 100,000 Law Enforcement Officers, 1984 – 2011

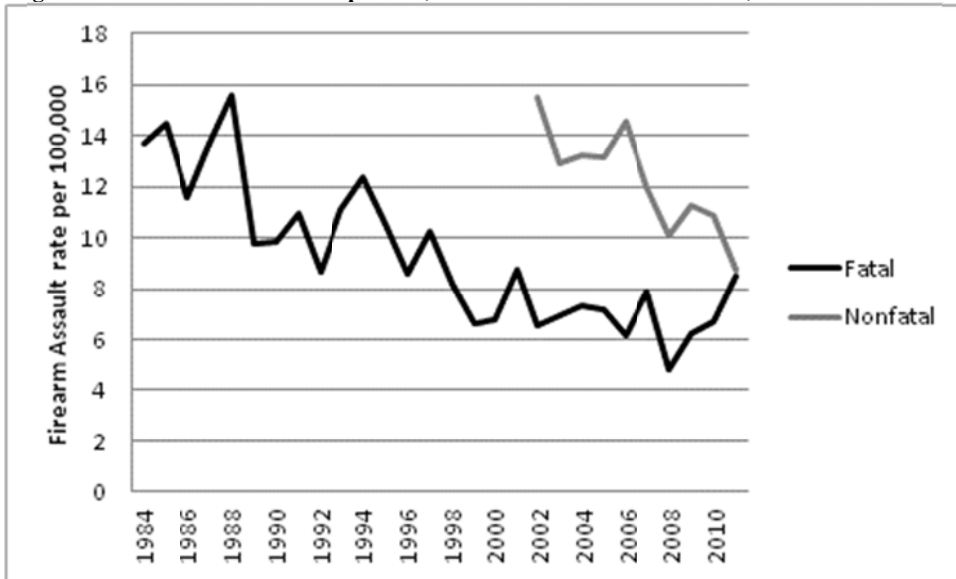


Figure 3.2: Three-Year Moving Average for Firearm Use in Fatal Law Enforcement Officer Assaults, 1980 – 2011

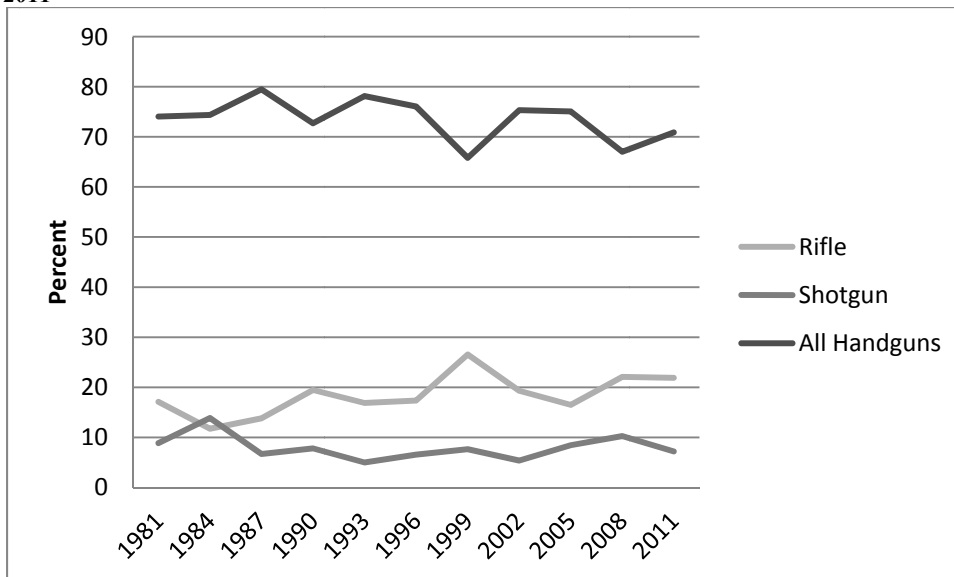


Figure 3.3: Handgun Caliber Used in Fatal Law Enforcement Officer Assaults, 1980 – 2011

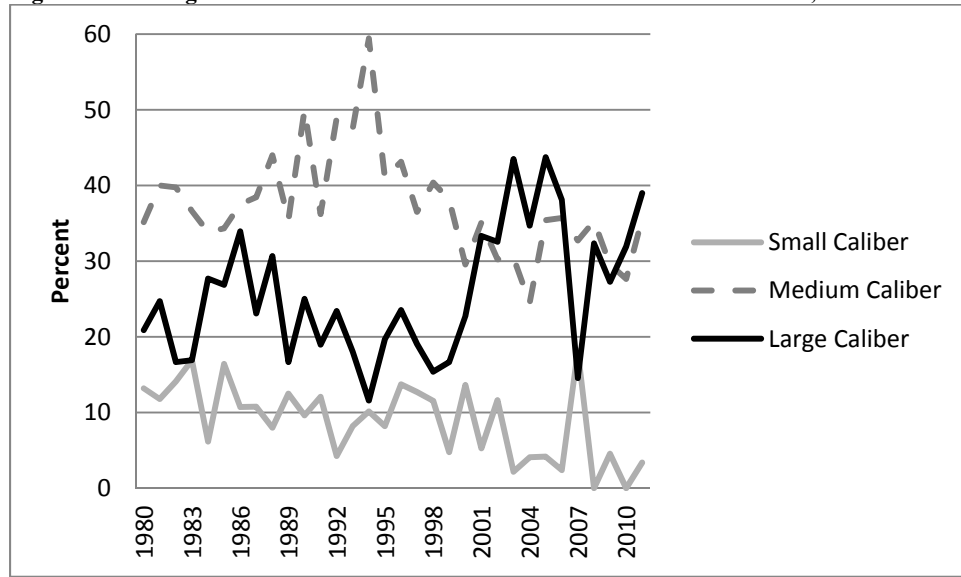


Figure 3.4: Firearm Use in Nonfatal Law Enforcement Officer Assaults, 2002 – 2011

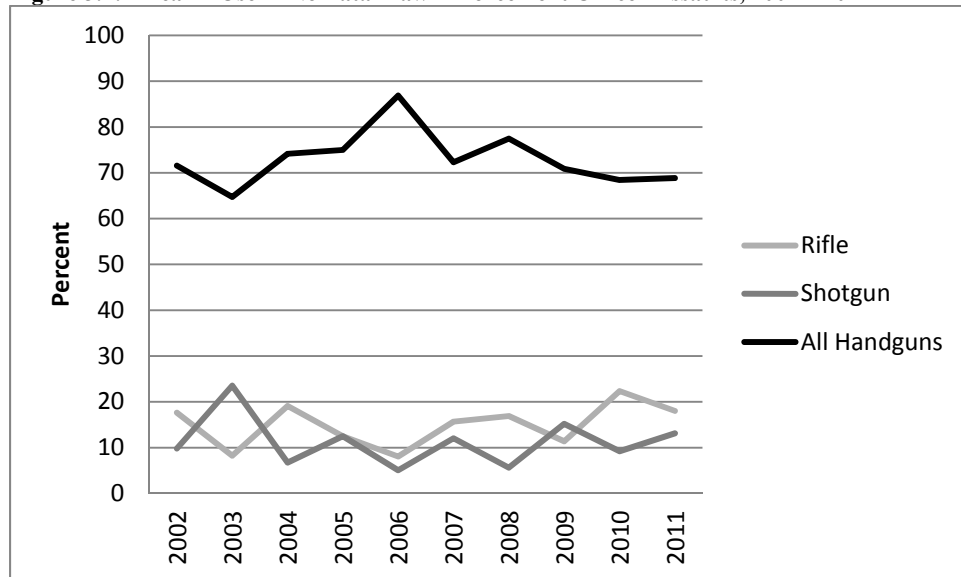
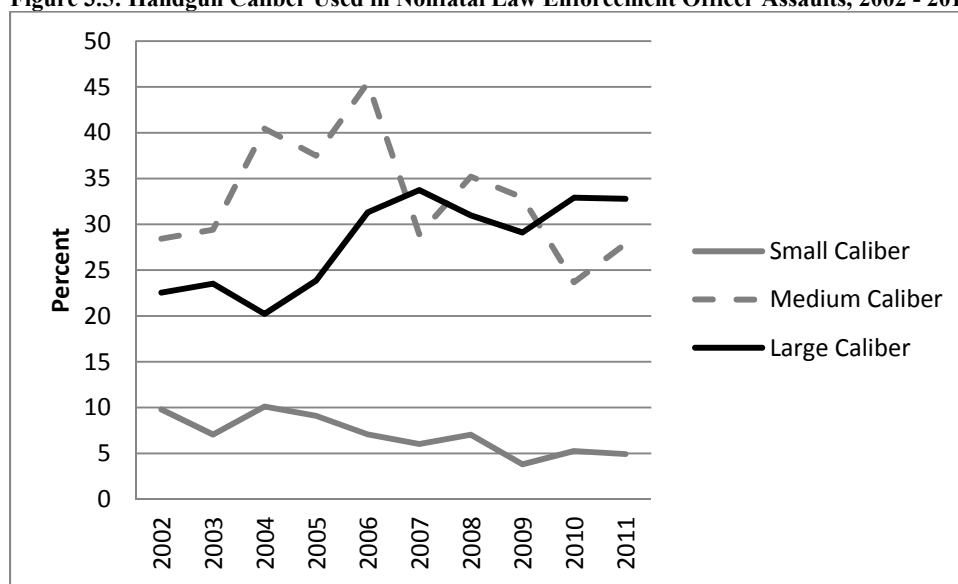


Figure 3.5: Handgun Caliber Used in Nonfatal Law Enforcement Officer Assaults, 2002 - 2011



In total, LEO body armor was circumvented 477 times during the study period. In most instances (84%), the firearm circumvented the body armor by entering above or below the vest, or through the side panel or armhole/shoulder area. There were 94 instances where the bullet penetrated the vest of a LEO. The body armor failed in 7 assaults and the firearm exceeded the vest specifications in 87 assaults. Seventy-nine percent of threshold exceeding vest penetrations were committed with a rifle and 57% of the vest failures were from assaults with large caliber handguns (Table 3.3). Since 2002 there have been 57 threshold exceeding vest penetrations, nearly 60% of these resulted in a fatality (Supplemental Table 3.1 and Supplemental Figure 3.1).

Table 3.3: Type of Circumvention of Law Enforcement Officer Body Armor by Firearm Type and Caliber for All Assaults, 1984 – 2011

Circumvention (%)	Small Caliber Handgun	Medium Caliber Handgun	Large Caliber Handgun	Shotgun	Rifle
Above Vest (n = 110)	7	38	28	9	18
Below Vest (n = 101)	8	37	36	9	10
Between Side Panels (n = 72)	12	44	28	6	10
Armhole or Shoulder Area (n = 119)	10	38	27	9	16
Penetrated Vest (Vest Failure) (n = 7)	0	29	57	0	14
Penetrated Vest (Exceeded Specifications) (n = 87)	0	8	12	1	79
Total (%) (n = 477)	8	34	27	7	24

For logistic regressions, small and medium caliber handgun categories were combined as no small caliber handguns exceeded the threshold of body armor. LEOs that were assaulted with a rifle had nearly 25 times greater odds ($p < 0.001$) of the bullet exceeding the threshold of the body armor compared to LEOs assaulted with a small or medium caliber handgun (Table 3.4). Though more assaults occurred at a distance of less than 5 feet, LEOs shot at distances of greater than 5 feet had higher odds of a threshold exceeding vest penetration compared to LEOs assaulted at a distance of less than 5 feet, an association that is likely confounded by firearm type due to shootings with rifles being longer distance shootings than shootings with handguns (Table 3.5).

Table 3.4: Simple Logistic Regression – Role of Firearm Type in Threshold Exceeding Vest Penetration

Reference = small/medium caliber handgun	OR^a	p-value	95% CI^b
Large Caliber Handgun	1.66	0.271	0.67 to 4.10
Shotgun	0.61	0.638	0.075 to 4.89
Rifle	24.94	< 0.001	12.08 to 51.50

^aOdds Ratio estimated from Simple Logistic Regression model.

^bConfidence Interval of the estimated OR.

Table 3.5: Simple Logistic Regression – Role of Distance from Suspect in Threshold Exceeding Vest Penetration

Reference = 00-05 feet	OR^a	p-value	95% CI^b
06-10 feet	1.45	0.336	0.68 to 3.14
11-20 feet	2.77	0.007	1.32 to 5.81
21-50 feet	3.25	0.007	1.38 to 7.65
51+ feet	7.00	< 0.001	3.08 to 15.90

^aOdds Ratio estimated from Simple Logistic Regression model.

^bConfidence Interval of the estimated OR.

When considering firearm type and caliber after controlling for distance, the odds of a threshold exceeding vest penetration due to a rifle increased to 53 times ($p < 0.001$) that of an assault with a small or medium caliber handgun. The association between longer distance and a threshold exceeding vest penetration was no longer significant after controlling for firearm type and caliber (Table 3.6).

Table 3.6: Multiple Logistic Regression – Firearm Type and Distance from Suspect in Threshold Exceeding Vest Penetration

Variable	OR ^a	p-value	95% CI ^b
Firearm Type			
<i>Small/medium caliber handgun</i>	<i>Ref</i>	--	--
Large Caliber Handgun	2.32	0.159	0.72 to 7.51
Shotgun	1.30	0.814	0.142 to 11.96
Rifle	53.34	< 0.001	18.69 to 152.19
Distance			
<i>00-05 feet</i>	<i>Ref</i>	--	--
06-10 feet	0.66	0.410	0.25 to 1.76
11-20 feet	1.10	0.846	0.42 to 2.89
21-50 feet	0.59	0.359	0.19 to 1.81
50+ feet	0.68	0.474	0.24 to 1.95

^aOdds Ratio estimated from Multiple Logistic Regression model.

^bConfidence Interval of the estimated OR.

Discussion

As with the decline in overall LEO assault rates, there was also decline in the firearm assault rate. The main contributor of this decrease is likely the increasing use of body armor seen among assaulted LEOs. For both fatal and nonfatal assaults, other than temporal fluctuation, there was no secular trend in the proportion of LEO assaults that were committed using a firearm.³⁰ This study looked specifically at firearm assaults, and neither was there much variation in the type of firearm used in fatal or nonfatal assaults. Where there was variation, however, was in the caliber of handgun used in assaults. There were declines in the use of small caliber handguns during fatal and nonfatal assaults. The decrease in small caliber handgun fatalities may be due to increasing use of body armor among LEOs. Small caliber handguns were not responsible for any vest penetrations; if LEOs are shot in the torso while wearing body armor they are unlikely to receive a fatal wound.

The decreasing use of small caliber handguns in nonfatal assaults presents an interesting possibility. Compared to larger caliber handguns, the decreased lethality of small caliber handguns may make them less attractive to criminals. If small caliber handguns were being used to assault LEOs but were not resulting in fatalities, one would expect to see their use increase in nonfatal assaults. This was not the case in this study. It is possible that criminals are shifting away from small caliber handguns toward firearms with increased lethal potential. Looking at the Bureau of Alcohol, Tobacco, Firearms and Explosives' Annual Firearms Manufacturing and Export Report, in 2011 small caliber handguns (.22, .25, and .32 caliber) represented only 15% of the firearms manufactured in the United States.⁷⁰ This indicates a potential decreased demand for small caliber handguns that may influence their use in LEO assaults.

Body armor does increase LEO safety for those shot in the torso.³⁴ However, there are a variety of ways in which body armor can be circumvented. LEOs may receive a wound to an area not covered by the body armor (e.g. the head). Bullets could enter through areas of the body armor that are less effective at protection (e.g. side panels) or vulnerable areas (e.g. armhole). Unfortunately, for some LEOs who were wearing armor and were shot in the torso (i.e. they should have been protected), there are firearms being used against them that can exceed the threshold and penetrate their vest. Although rifles are less commonly used in LEO assaults than handguns, being shot with a rifle greatly increases the odds of a vest penetration. Data from this study indicate that the odds of vest penetration were 53 times higher than that of small or medium caliber handguns after controlling for distance.

Before accounting for firearm type, increasing distance from the suspect was significantly associated with threshold exceeding vest penetration. This is likely due to rifles accounting for the vast majority of firearms responsible for these penetrations. A bullet leaving a rifle could maintain a velocity high enough to cause a threshold exceeding vest penetration from a greater distance. A handgun may have the capacity to exceed the threshold at a closer distance. This may explain the positive association between large caliber handgun use and vest penetration seen in the simple logistic regression, though the findings were not statistically significant.

These findings have meaningful implications for LEO safety. Handguns are the most common form of firearm used in both fatal and nonfatal assaults. However, in contrast in to the findings of small .32 caliber handguns being associated with increased risk of fatality in the 1980s, this study found increases in large caliber handguns being used in LEO assaults as well as a potential increase in the use of rifles in fatal LEO assaults. When these firearms are used by suspects it represents a significant occupational hazard for LEOs.

There has been an increasing trend in body armor use among assaulted LEOs.³⁰ A survey by the Police Executive Research Forum found that LEOs were more likely to report wearing body armor in departments with mandatory body armor policies.⁷¹ Many manufacturers have five year warranties on body armor, but the effectiveness of body armor over time is influenced by care and use – LEOs that wear their armor regularly may need their armor replaced more frequently.⁷² The National Institute of Justice defines five classifications of body armor: IIA, II, IIIA, III, and IV. Each of these classes of body armor are rated to protect against and medium caliber handguns. Type IIIA also

provides protection against large caliber handguns up to .44 caliber. Type III provides protection against rifles and Type IV protects against armor piercing rifles.⁷³ As the level of protection body armor provides increases, the level of comfort for the wearer decreases.⁵³ The challenge is to find the right balance matching the types of firearms being used against LEOs with a level of protection in body armor that will maintain comfort and increase the likelihood of use among LEOs.

LEOs in this study that had threshold exceeding vest penetrations were wearing armor that was not rated for the type of firearm with which they were shot. It is unknown if this was a result of comfort or rifles not being perceived as a risk LEOs would likely face. Future research on this topic should include an examination of the specific type of body armor LEOs are wearing and why that type was chosen. The Matching Grant Program for Law Enforcement Armor Vests, which provides grants to purchase body armor for LEOs can help to address issues of cost⁷⁴ – if the choice of body armor provided to LEOs in a given jurisdiction is driven by cost considerations. Efforts should be made to improve the comfort of the more protective types of body armor so that LEOs can be protected from the types of firearms with which they are being shot.

There are a few limitations in this study. The LEOKA database has been shown to undercount LEO homicides due to the FBI's strict definition of line-of-duty assaults.⁵⁹ This could also lead to an undercounting of nonfatal assaults. There are two key variables related to vest penetration that are not collected in the dataset: type of ammunition used by the suspect; and the type of body armor used by the LEO. Suspects could use ammunition specifically designed to circumvent body armor through penetration. A LEO may have been wearing armor, but the armor may not have been designed or certified to

protect against high velocity weapons. It is difficult to gain a clear picture of the role of firearms in LEO assault without data on these two important variables.

This study also has a number of strengths. This study utilizes a dataset that provides a great amount of detail for both fatal and nonfatal assaults. The prevalence of firearm use in LEO assaults is not decreasing nationally. This study fills an important gap in the literature by better elucidating on the role of firearms in both fatal and nonfatal LEO assaults including differences in firearm type and handgun caliber. Additionally, this study identifies key areas for potential research and policy changes to improve LEO safety.

Firearms are a significant occupational hazard that LEOs face, and this risk is not decreasing over time. Future areas of research should explore the types of ammunition being used by suspects and the type of body armor used by LEOs. LEOs may not have the time to don body armor while responding to a call or before interacting with suspects. Policies should be introduced that require body armor use by all LEOs, all the time. The body armor that is used by LEOs should offer protection against the kinds of firearms being used to assault them so they are better protected while protecting their communities.

Chapter Four: Manuscript Three

State Policy Changes and Law Enforcement Officer Assaults

Cassandra Kercher Crifasi

Johns Hopkins Bloomberg School of Public Health

Department of Health Policy and Management

Abstract

Objective: To evaluate the impact of state-level policy changes on assaults of law enforcement officers (LEOs) in the United States.

Methods: Pooled time series and cross-sections with Negative Binomial regression was used to estimate the impact of changes to right-to-carry (RTC), three strikes, and permit-to-purchase (PTP) handgun laws on fatal and nonfatal assaults of LEOs. LEO assaults were stratified by weapon type (all methods, firearm, and handgun) and whether the assault was fatal. Data were available for the period 1984-2010 for fatal assaults and for 2002-2010 for nonfatal assaults from the Federal Bureau of Investigation's Law Enforcement Officers Killed and Assaulted database.

Results: RTC laws showed no association with fatal or nonfatal LEO assaults. Three strikes laws were associated with a 34% increase in risk of fatal assaults to LEOs ($p = 0.015$). Following Missouri's 2007 repeal of its PTP legislation, the risk of nonfatal handgun assaults was more than 3 times higher ($p=0.033$).

Conclusions: Three strikes laws and the repeal of Missouri's PTP handgun law increased the risk of firearm-related assaults to LEOs. Policymakers should consider potential risks and benefits to LEOs when considering policies related to crime and firearms.

Introduction

Law enforcement is an occupation with inherent risk to officers. Law enforcement officers (LEOs) respond to crimes in progress, handle dangerous suspects, and investigate crimes, among other duties.^{4,5} LEOs experience an increased risk of assault, compared to other public service occupations, due to the nature of their interaction with the criminal suspect and response to volatile situations; LEOs often work alone or in small numbers, in high crime areas, and late at night or during early morning hours.⁷ While the rates of fatal LEO assaults have been on the decline for the past several decades, their homicide victimization rates are consistently higher than that for the general population and is currently nearly twice as high – in 2011 the LEO homicide rate was 8 per 100,000,²⁶ while the general population homicide rate was 4.7 per 100,000.²⁴ While there are a number of important factors that can influence the homicide of a LEO, the environment in which LEOs work is affected by state laws and policies.

There have been many studies of the effect of concealed carry weapons laws, commonly referred to as right-to-carry (RTC) laws, on homicide and other violent crimes in the general population.^{39,75,76} Some of the research has also explored the effect these RTC laws may have on LEO assault. RTC laws could be relevant to LEO safety as these laws are likely to increase the number of handguns carried in public. Many of those at highest risk for committing firearm violence are prohibited from possessing firearms (e.g., felons, anyone subject to a court-issued restraining order for domestic violence, juveniles) and therefore cannot obtain a permit to carry a concealed handgun. But individuals with extensive histories of arrest for serious crimes and convictions for misdemeanor crimes involving violence, drug, or alcohol abuse may legally possess

firearms and legally carry concealed handguns in many states. There have been inconsistent findings on the association between RTC laws and fatal LEO assaults in prior research.³⁸⁻⁴⁰ This study evaluated the impact of RTC laws in conjunction with other relevant crime and gun policies to determine if RTC laws are associated with risk of LEO assault.

Three strikes laws (i.e., criminals receive harsher sentences for committing a third serious crime) became popular among states during the mid-1990s in an effort to deter chronic offenders from committing serious crimes. Early evaluations of the law's impact in California (which had the broadest application) indicated increases in serious violent crime, including homicide, in the years following passage.^{77,78} A more recent analysis of the laws' effects in cities found a positive association between three strikes laws and homicide, and no significant reductions in crime.⁷⁹ The relationship between three strikes laws and fatal LEO assaults has also been evaluated. Moody and colleagues found that three strikes laws were associated with a 44% increase in the expected numbers of fatal LEO assaults.⁴⁰ These laws were implemented to deter serious violent crime, but appear to be decreasing LEO safety. This may be due, at least in part, to chronic offenders killing LEOs to evade capture and potential life imprisonment.

There are a number of gaps that exist in current federal firearm policy. One such gap is that federal law only requires a background check and record keeping for purchases from federally license dealers. Some states have taken steps to address this gap through permit-to-purchase handgun (PTP) laws. PTP laws require all prospective handgun purchasers to pass a background checks and both licensed and unlicensed sellers can only sell a handgun to valid permit holders. Nine of twelve states with PTP laws

require potential handgun purchasers to apply in person at a law enforcement agency where they are also photographed and sometimes fingerprinted.⁸⁰ States with PTP laws also often have more strict standards for legal gun ownership and more expansive background checks that access local, state, and federal records. In-person applications with law enforcement could increase the integrity of the background check and potentially deter straw purchases made on behalf of prohibited persons.

PTP laws have been associated with decreased diversion of guns to criminals⁸¹ and lower rates of firearm homicide⁸² and suicide.⁸³ Missouri repealed its PTP law in August of 2007. This policy change was associated with significant increases the diversion of guns to criminals⁸¹ and in the age-adjusted firearm homicide rates.⁴¹ If the repeal of Missouri's PTP law increased the availability of firearms to prohibited persons, in addition to leading to more homicides, it could have also increased firearm-related assaults to LEOs.

The impact of PTP laws and specifically Missouri's repeal have yet to be evaluated for associations with LEO homicide. Additionally, none of the policies discussed have been studied with respect to nonfatal assaults (those committed with a firearm or knife that result in an injury). Nonfatal assaults share similar characteristics with fatal assaults and are key to understanding the contexts in which assaults occur so that the true magnitude of a policy's effect on LEO safety can be elucidated. RTC, three strikes, and PTP laws are evaluated together due to their particular relevance to the study of LEO safety as they have the potential to influence the ways in which suspects, criminals, and citizens interact with law enforcement.

Methods

Design

This study used pooled time series and cross-sectional data from 1984 through 2010 to evaluate the associations between state policy changes and LEO assaults. More recent data are now available for LEO assaults; however, at the time of these analyses data for important covariates were not available after 2010. The policy changes under study were RTC, three strikes, and PTP handgun licensing laws. Annual, state-level counts of LEO assaults were stratified by outcome (fatal or nonfatal) and weapon type (all methods, handgun, non-handgun) to create six dependent variables to estimate associations with policy changes. Because both RTC and PTP laws are specific to handguns, separating out handgun versus non-handgun assaults allowed for increased specificity of testing for policy effects. The starting year for the study period for fatal assaults, 1984, was chosen since it is the first year for which state-level crime rates are available. The Federal Bureau of Investigation (FBI) began collecting data on nonfatal assaults in 2002, restricting the nonfatal study period from 2002 through 2010.

Data Measures and Sources

Counts of LEO assaults were generated from the FBI's Law Enforcement Officers Killed and Assaulted database.⁵⁶ The FBI compiles this database from reports of every line-of-duty fatal assault and nonfatal assaults committed with a firearm or knife that result in an injury as part of the Uniform Crime Reporting program (UCR).² The database includes a variety of variables including the type of weapon used by the suspect, which is used to stratify the dependent variables.

For the policies of interest, indicator variables were created and coded as 0 for the years prior to the law, a proportion for the fraction of days in the year the law was in effect, and 1 for each subsequent year with the law, which is a method that has been used in previous research investigating policy impacts.^{40,41} For example, if a state enacted a three strikes law on July 1, 1995 the three strikes indicator would be coded as 0 for years 1984-1994, 0.5 for 1995, and 1 for years 1996-2010. For RTC and PTP laws, state legislation was first identified using Ludwig and Cook's book, *Evaluating Gun Policy*,⁸⁴ which provided data up to the year 2000. For policy changes after 2000, the Law Center to Prevent Gun Violence policy summaries for RTC⁸⁵ and PTP⁸⁰ were used to identify state legislation. Moody and colleagues⁴⁰ provided the state legislation for three strikes laws.

Once the appropriate legislation was identified from these sources and verified, the laws were reviewed for each state to determine a law's effective date and if any changes to the legislation occurred during the study period. For RTC laws, states were considered to have "permissive" laws if state authorities had no discretion in issuing permits or the state did not require a permit to carry a concealed handgun. For three strikes and PTP laws, the indicator variable represented the presence or absence of said law. During the study period, twenty states had permissive RTC laws (15 law changes during study period), 24 states had three strikes laws (24 law changes during study period), and 13 states had PTP laws (2 law changes during study period) (Table 4.1).

It is possible that the passage of these laws is endogenous with LEO assaults which would result in misspecification and bias estimates of the policies' effects. However, as discussed by Moody et al⁴⁰ LEO homicides are rare events that are unlikely

to lead to passage of a law on their own. Additionally, the time it takes for legislation to be drafted, approved, and implemented makes it even less likely that endogeneity exists. Therefore, delaying the implementation of the policies in the models would not be appropriate in this case, and could potentially introduce endogeneity into the models.

The control variables included in the models were state-level rates of violent crime and arrest per 100,000 population;⁵⁶ percent poverty;⁸⁶ percent unemployment (among those age 16 and older);⁸⁷ incarceration rates per 100,000 population;⁸⁸ proportion of state population black, Hispanic, and age 18-34 interpolated between census years;⁸⁹ percent population living in Metropolitan Statistical Areas (MSA);⁵⁶ gun availability (calculated as the ratio of firearm suicide to all suicide);^{90,91} population;⁹¹ and state aggregated law enforcement expenditures per 100,000 population.⁹²

Analytic Methods

All of the covariates outlined above tested for inclusion in the model. In addition to the policy indicators, state aggregated law enforcement expenditures, arrest rates for violent crime, and the number of LEOs were included as theoretically mandatory independent variables. After addressing issues of collinearity and variance inflation, step-wise regression was used to select additional covariates and develop the primary model (the model specifications and fit statistics are available in the appendix – Supplemental Table 4.1 – 4.6). The primary model included state aggregated law enforcement expenditures, arrest rates for violent crime, and the number of LEOs, as well as percent poverty, percent MSA, and gun availability.

To estimate the association between RTC, three-strikes, and PTP handgun laws and LEO assaults, regression models were estimated using state and year fixed effects.

State fixed effects models were used to control for time-invariant factors and omitted variables associated with LEO assault risks in order to estimate the policies' effects. The utility of a random effects model was evaluated using the Hausman test.⁹³ A random effects model could have been used for the dependent variables ($p > 0.05$) except for nonfatal handgun assaults ($p < 0.001$). The results of a fixed effects model would be consistent even if the Hausman test indicates that random effects could be used. Due to the significance of the Hausman test for nonfatal handgun assaults, all models were estimated using fixed effects to ensure consistency across models. Analyses were restricted to the state-level due to small sample sizes and inconsistencies in reporting of county level crime data.^{94,95} Standard errors were adjusted to account for clustering by state.

Counts of fatal and nonfatal assaults are restricted to integers. Therefore, regression methods designed for count data such as Poisson and Negative Binomial regressions are appropriate. The use of Poisson regression with fixed effects is an attractive option because even if the distribution requirements are not met, the parameter estimates are consistent. However, since the variance was greater than the mean for both fatal and nonfatal assaults the use of Poisson regression would result in standard errors that are underestimated leading to smaller p-values, though the parameter estimates would still be consistent.⁹⁶

To account for this over-dispersion in the data (likelihood ratio test of $\alpha = 0$, $p < 0.001$), Negative Binomial regression is a better option for these analyses. There is evidence suggesting that a Negative Binomial does not function as a true fixed effects model as it does not properly condition out the fixed effects,^{97,98} but it is currently the

best available analytic method for use with Stata. The results of the Negative Binomial regression will be presented in the text. Estimated policy effects from the Poisson regression are available in Supplemental Tables 4.7 and 4.8 in the appendix for fatal and nonfatal assaults respectively, as well as overall assaults for 2002-2010 in Supplemental Table 4.9. Model results for each dependant variable with the covariates in the primary model are included in the appendix as Supplemental Tables 4.10, 4.11, and 4.12 for Negative Binomial and Supplemental Tables 4.13, 4.14, and 4.15 for Poisson, for fatal, nonfatal, and overall assaults. The number of LEOs in each state⁹⁹ was used as an offset variable, and the policy effect estimates are presented as incident rate ratios (IRR).

Analyses were conducted using Stata IC v 11.2.⁵⁸ This study was deemed to be “not human subjects” research by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Table 4.1: States with RTC, three strikes, and PTP laws with year of implementation[†]

RTC 15 law changes	Three strikes 24 law changes	PTP 2 law changes
Alaska ⁱ	Arkansas ^{vi}	Connecticut ^{vi}
Arizona ⁱ	California ⁱ	Hawaii
Florida ⁱⁱ	Colorado ⁱ	Illinois
Idaho ⁱⁱⁱ	Connecticut ⁱ	Iowa
Kentucky ^{iv}	Florida ^{vi}	Massachusetts
Louisiana ^{iv}	Georgia ^{vi}	Michigan
Mississippi ⁱⁱⁱ	Indiana ⁱ	Minnesota
Missouri ^v	Kansas ⁱ	Missouri*
Nebraska	Louisiana ⁱ	Nebraska
Nevada ^{vi}	Maryland ⁱ	New Jersey
New Mexico	Montana ^{vi}	New York
North Carolina ^{vi}	Nevada ^{vi}	North Carolina
Ohio ^{vii}	New Jersey ^{vi}	
Oklahoma ^{vi}	New Mexico ⁱ	
South Carolina ^{iv}	North Carolina ⁱ	
Tennessee ⁱ	North Dakota ^{vi}	
Texas	Pennsylvania ^{vi}	
Vermont	South Carolina ^{iv}	
Washington	Tennessee ⁱ	
West Virginia ^{viii}	Utah ^{vi}	
	Vermont ^{vi}	
	Virginia ⁱ	
	Washington ^{ix}	
	Wisconsin ⁱ	

[†]Unless otherwise noted, the laws were in effect across the entire study period
Law was passed: ⁱ1994; ⁱⁱ1987; ⁱⁱⁱ1990; ^{iv}1996; ^v2003; ^{vi}1995; ^{vii}2004; ^{viii}1989; ^{ix}1993
Law was repealed: *2007

Results

Fatal and Nonfatal Assaults to Law Enforcement Officers

From 1984 to 2010 there were 1,569 fatal assaults of LEOs. From 2002 to 2010 there were 1,169 nonfatal assaults of LEOs. Descriptive statistics for LEO assaults and dependent variables are presented in Table 4.2. The variance is presented to illustrate the over-dispersion present in the data.

Table 4.2: Descriptive Statistics for Law Enforcement Officer Assaults and dependent variables

Variable	Fatal (n = 1569)	Nonfatal (n = 1169)
Mean Age in years	36.7	35.8
Mean Months Experience	115.1	119.7
% Male	97	95
% White	85	87
% Firearm	92	66
Handgun	68	49
Rifle	16	9
Shotgun	7	7
Dependent Variable	Mean	Variance
Fatal Assaults – All Methods	1.15	2.85
Fatal Handgun Assaults	0.77	1.52
Fatal Non-Handgun Assaults	0.3	0.5
Nonfatal Assaults – All Methods	2.6	17.91
Nonfatal Handgun Assaults	1.26	4.9
Nonfatal Non-Handgun Assaults	1.34	5.74

Estimates of Policies' Effects on Fatal Assaults

The primary regression results for fatal assaults are shown in Table 4.3. Across the dependent variables RTC laws showed no association with total fatal assaults of LEOs. Three strikes laws were associated with a 34% increase in fatal LEO assaults committed overall ($p = 0.015$, 95% CI 1.06 to 1.71). Three strikes laws were marginally associated with a 26% increase in fatal assaults committed with a handgun ($p = 0.099$, 95% CI 0.96 to 1.65). The presence of a PTP law was not statistically significantly

associated with any of the dependent variables for fatal LEO assaults. There were too few fatal assaults committed with non-handguns (knives/cutting instrument or long guns).

The primary model for policy effects on non-handguns would not converge.

Table 4.3: Primary Model Results for Fatal Law Enforcement Officer Assaults, 1984-2010

Dependent Variable	IRR ^a	95% CI ^b	p-value
<i>RTC</i>			
Total	1.08	0.85 to 1.38	0.514
Handgun	0.98	0.74 to 1.30	0.896
<i>Three Strikes</i>			
Total	1.34	1.06 to 1.71	0.015
Handgun	1.26	0.96 to 1.65	0.099
<i>PTP</i>			
Total	1.10	0.45 to 2.70	0.835
Handgun	0.56	0.19 to 1.64	0.290

^aIncident Rate Ratio Estimated from Negative Binomial Regression.

^bConfidence Interval of the estimated IRR.

Estimates of Policy Effects on Nonfatal Assaults

The primary regression results for nonfatal assaults are shown in Table 4.4. There were no changes to three strikes law during this period so the indicator representing three strikes laws was dropped from the model. Additionally, the only change in PTP laws was the repeal of Missouri's PTP law effective August 28, 2007.

Again, across the dependent variables, there were no statistically significant associations between RTC laws and nonfatal LEO assaults. It is important to note that the only changes to RTC laws were Missouri and Ohio passing permissive RTC laws. Following Missouri's repeal, the risk of overall nonfatal assault was more than twice as high ($p = 0.039$, 95% CI 1.04 to 4.93). The risk of nonfatal handgun assaults was also more than 3 times higher in Missouri following its PTP repeal ($p = 0.033$, 95% CI 1.10 to 9.59).

Table 4.4: Primary Model Results for Nonfatal Law Enforcement Officer Assaults, 2002-2010

Dependent Variable	IRR^a	95% CI^b	p-value
<i>RTC</i>			
Total	0.78	0.42 to 1.43	0.419
Handgun	0.73	0.32 to 1.63	0.411
Non-Handgun	0.92	0.38 to 2.24	0.850
<i>Missouri's PTP Repeal</i>			
Total	2.27	1.04 to 4.93	0.039
Handgun	3.25	1.10 to 9.59	0.033
Non-Handgun	1.45	0.52 to 4.05	0.477

^aIncident Rate Ratio Estimated from Negative Binomial Regression.

^bConfidence Interval of the estimated IRR.

When fatal and nonfatal assaults were combined to assess policy effects on overall assaults for the period 2002 – 2010, the policy impact of Missouri's repeal on handgun assaults was no longer significant ($p = 0.132$, 95% CI 0.81 to 5.10). This indicates that the policy effects were restricted to an association only with nonfatal handgun assaults. Neither were RTC laws significantly associated with overall LEO assaults (Table 4.5).

Table 4.5: Primary Model Results for Overall Law Enforcement Officer Assaults, 2002-2010

Dependent Variable	IRR^a	95% CI^b	p-value
<i>RTC</i>			
Total	0.93	0.54 to 1.58	0.778
Handgun	1.01	0.52 to 1.98	0.971
Non-Handgun	0.92	0.42 to 2.02	0.836
<i>Missouri's PTP Repeal</i>			
Total	1.51	0.69 to 3.28	0.300
Handgun	2.03	0.81 to 5.10	0.132
Non-Handgun	1.14	0.39 to 3.37	0.807

^aIncident Rate Ratio Estimated from Negative Binomial Regression.

^bConfidence Interval of the estimated IRR.

Discussion

Right-to-carry (RTC), three strikes, and permit-to-purchase (PTP) handgun laws are particularly important when considering factors that influence LEO safety. These laws have the potential to change the ways in which suspects interact with LEOs. RTC laws are a commonly debated policy in which risk to LEOs is often raised. This debate centers on the issue of legal carrying of concealed weapons that could be used either in the assault or aid of a LEO responding to a call for service. Prior studies have produced mixed findings concerning the effect of RTC laws on LEO safety. This study improves upon prior studies by estimating impacts on both fatal and nonfatal assaults to illustrate the most complete picture of the relationship between RTC laws and LEO safety. Findings from this study indicate no significant effects of RTC laws on the risk of fatal or nonfatal assaults of LEOs.

Three strikes laws were popular in the mid-1990s as a way to crack down on chronic offenders committing serious crimes. However, prior research on the effects of three strikes laws by Moody and colleagues⁴⁰ indicates a serious unintended consequence of these laws – the homicide of LEOs. The results of this study are consistent with their findings showing that these laws increase fatal assaults to LEOs. Three strikes laws present potential significant risk for fatal assaults overall. There was no association between three strikes laws and fatal handgun assaults in the models, but this is not surprising since there is nothing inherent to three strikes laws that would make them any more or less impactful on fatalities committed with a handgun. Given that prior research also shows no public safety benefit and likely negative effects on crime from three strikes laws, policymakers should reassess the wisdom of these costly laws.

Research by Margarita³¹ found that fatal assaults of LEOs were situational and contextual, often occurring during the suspects' attempts to evade capture after committing a crime. These findings, along with those of Moody et al, lend support to the theory that, while three strikes laws were designed to deter serious crime, they may increase the risk for fatal assault – presumably by criminals wanting to avoid long sentences or potential life imprisonment. Future research on the association of three strikes laws and fatal LEO assault should include a revisit of Margarita's work with suspects that killed LEOs. It is possible that much has changed in the way suspects view killing a LEO over the last 30 years. In order to answer this question more fully, it is necessary to have an updated understanding of the context of a fatal LEO assault from the perspective of the perpetrator.

Missouri repealed its PTP law in 2007. Prior to the repeal, anyone wanting to purchase a handgun in Missouri had to apply in-person at a law enforcement agency and be photographed. Sellers, both licensed and unlicensed, were only allowed to sell to a purchaser with a valid permit. This could have reduced or deterred the occurrence of straw purchases, where a non-prohibited person purchases a gun on behalf of a prohibited person, since the purchaser had to engage with law enforcement prior to the sale. Additionally, since background checks were conducted at the local level, agencies may have been less likely to miss prohibiting factors – compared to the federal system that might not be up to date with local records.

Following Missouri's repeal, background checks were no longer required for private gun sales, making it easier for prohibited persons to obtain guns. Findings by Webster and colleagues demonstrated a sharp increase in both the number of crime guns

recovered in Missouri that were originally sold within the state (an indicator of diversion of guns to criminals)⁸¹ and firearm homicide rates⁴¹ after the repeal. Both of these studies point to a changing illegal gun market in Missouri in which it is easier for criminals to obtain guns and use those guns to commit violent crime. This could lead to increased risk of firearm assaults against LEOs who are responding to these crime scenes. This study's findings support this theory. There was a significant increase in the risk of nonfatal handgun assaults following Missouri's repeal. Since the PTP law was specific to the sale of handguns, we would expect the largest impact to be seen among handgun assaults. Adding to the specificity of the findings, there was no corresponding increase in nonfatal non-handgun assaults occurring in Missouri after the repeal. The lack of an association between total handgun assaults (fatal and nonfatal) indicates that the impact of Missouri's repeal was restricted to nonfatal handgun assaults. The increasing use of body armor among LEOs and the rarity of LEO homicide are likely factors contributing to the specificity of effects.

There are limitations of this research. There is potential for omitted variable bias in this study. For example, data on law enforcement practices was not available (such as dispatch or response policies). However, for this to present a bias in the estimates of policy effects, these practices would have to be associated with the state policies in question. Additionally, any longitudinal study of crime trends in the U.S. has the potential for bias if the study does not control for the crack cocaine epidemic which is thought to have played a key role in the sharp increase in homicides during the late 1980s and early 1990s.¹⁰⁰ The ways in which changes in the market for crack might influence

risks to law enforcement are likely being controlled for in the current study through statistical controls for changes in violent crime and arrest rates.

As with most studies of the effects of state laws, there is the potential for selection bias. Selection bias is elevated if states that adopted the laws were on different trajectories for LEO assaults prior to passing the law than states that did not enact the laws. Controlling for state-level factors across time such as violent crime that might prompt the enactment of these laws likely reduced any potential influence of selection bias. Additionally, a model was tested to assess if unmeasured differences existed in states that passed these laws one and two years prior to implementation (results not shown). There was no evidence of effects for RTC, further supporting the conclusion that RTC laws are not associated with rates of fatal or nonfatal assaults. For three strikes laws, the point estimate remained positive and statistically significantly associated with total fatal assaults. The model results for Missouri's repeal of its PTP law on nonfatal LEO assaults also remained positive and statistically significantly associated. The models examining overall assaults 2002 through 2010 indicate positive and significant associations between Missouri's repeal and overall assaults in the state after controlling for one and two years prior to the repeal. The impact on non-handgun assaults remained insignificant.

There are also a number of strengths in this study. While the LEOKA's strict definition of a "LEO" often results in undercounting of LEO homicides compared to other data sources,⁵⁹ the database contains a number of important details that allow for the stratification of assaults by weapon type to better estimate the policy effects. Additionally, the LEOKA database is the only source for details on nonfatal LEO

assaults. This study used one of the longest study periods, 27 years, to analyze the impact of these policy changes on fatal assault. This is also the first study to estimate the impact of PTP laws on LEO assault, and the first to examine the effects of state-level policies on nonfatal LEO assaults. This study controlled for a wide range of covariates related to LEO risk of assault, but over-controlling was also avoided by removing redundant and/or multicollinear covariates to generate generalizable estimates of state policy impacts on law enforcement.

Law enforcement officers are vital to the safety and function of society. It is important that they are provided with an environment that is as safe as possible in which to work. State policies affect this environment; RTC, three strikes, and PTP laws are particularly relevant due to their potential to influence the ways in which criminals interact with law enforcement. It is important when considering the passage or repeal of state laws related to crime or firearms to also reflect on how a law may affect law enforcement. Though three strikes laws were designed to deter serious crime, particularly among repeat offenders, these laws led to increases in fatal assaults of LEOs. Missouri's repeal of its PTP law made it easier for criminals or prohibited persons to purchase firearms and led to an increase in nonfatal assaults of LEOs. This increase was most notable in assaults with handguns; the type of weapon previously more tightly regulated by Missouri's PTP law. LEOs are essential to keeping communities safe and place themselves in harm's way to provide that safety. Given this important role, policymakers should place a premium on the impact of public policies on LEO safety.

Chapter Five: Conclusion

Summary of Findings

Aim 1: To describe the situational contexts in which Law Enforcement Officers are assaulted and compare these contexts between fatal and nonfatal assaults.

The results of manuscript one indicate a number of similarities between fatal and nonfatal LEO assaults. The vast majority of fatal assaults and two-thirds of nonfatal assaults were committed with a firearm. The case fatality rate for assaults on LEOs is on the rise. More than half of both fatally and nonfatally assaulted LEOs were on a one-officer vehicle assignment at the time of the assault. Ambush and unprovoked attacks resulted in a higher proportion of fatal than nonfatal outcomes.

Aim 2: To describe and evaluate the role of suspects' firearm use in Law Enforcement Officer assaults and circumvention of body armor.

The results of manuscript two indicate that firearm use by suspects represents a significant occupational hazard for law enforcement. Handguns were responsible for nearly 75% of both fatal and nonfatal assaults, but rifles were responsible for almost 80% of threshold exceeding vest penetrations. Being shot with a rifle was associated with 53 times greater risk of a threshold exceeding vest penetration compared to being shot with a small or medium caliber handgun. Since 2002 there have been 57 threshold exceeding vest penetrations with nearly 60% resulting in a fatality. These findings may be associated with the increasing case fatality rate for assaults despite an increase in body armor use among LEOs seen in manuscript one. Among LEOs wearing body armor, the odds ratio of a fatal outcome following a threshold exceeding vest penetration was 1.72 ($p = 0.036$).

Aim 3: To evaluate the impact of state-level policy changes on fatal and nonfatal assault of Law Enforcement Officer.

The results of manuscript three indicate that permissive RTC laws are not associated with increased or decreased risk for fatal and nonfatal LEO assaults. Three strikes laws were associated with a 34% increase in fatal LEO assaults. Following Missouri's 2007 repeal of its PTP law, the associated risk of nonfatal handgun assaults was more than 3 times higher.

Policy Implications

The 10th Amendment of the federal constitution gave police powers to the state. The result is a lack of a federal agency to establish regulations for state-level law enforcement agency practices and procedures. Additionally, there are very few state-level agencies to manage law enforcement. This affects the ways in which the findings of this dissertation have the potential to impact policy; necessitating individual departments, unions, and law enforcement organizations, such as the International Association Chiefs of Police, develop best practices for law enforcement.

The percent of LEOs wearing armor at the time of an assault is increasing; however, LEOs experiencing nonfatal assaults were more likely to be wearing body armor than fatally assaulted LEOs. The effectiveness of body armor at reducing risk of fatality has been previously demonstrated,³⁴ yet not all LEOs are wearing armor. LEOs in areas with enforcement of strong mandatory wear policies were more likely to report wearing body armor.⁷¹ Jurisdictions should consider mandatory body armor policies for all on-duty LEOs at all times. The emphasis of these policies should focus not only on

saving lives, but also limiting potentially disabling injuries. Alternatively, state or local government could consider passing legislation to mandate the use of body armor by LEOs as law enforcement agencies receive at least some portion of their funding from state and local taxes.

Currently, the Occupational Safety and Health Administration (OSHA) has not issued a rule concerning the use of body armor for law enforcement. However, OSHA does consider body armor to be PPE that would be provided at no cost to LEOs and required to offer adequate protection should departments require their use.¹⁰¹ OSHA should consider providing a rule specific to the mandatory use of body armor among on-duty LEOs. OSHA could partner with the National Institute of Justice and law enforcement organizations to develop the standard. A requirement by OSHA for mandatory wear of body armor would bypass the need for individual departmental or local government policies.

It is unlikely that every department or jurisdiction would be able to afford to provide body armor in order to enforce a mandatory wear policy. State and local law enforcement agencies should make use of the Bulletproof Vest Partnership to purchase body armor for their LEOs. The Bulletproof Vest Partnership has aided in the purchase of over one million vests for more than 13,000 jurisdictions since 1999; the program requires that applying jurisdictions have a mandatory wear policy.¹⁰²

Providing body armor to LEOs and requiring its use is only one piece of the issue. As manuscript two indicates, LEOs are being shot with large caliber, high velocity firearms for which their body armor is not rated. The findings from this dissertation support the need for body armor technologies that offer greater protection while

maintaining comfort for the wearer. The National Institute of Justice, which certifies body armor, could incentive the development of innovative designs and technologies to improve LEO safety.

Ambush and unprovoked attacks of LEOs are on the rise, and the results of these assaults are often fatal. Jurisdictions should consider partnering LEOs to allow them to watch each others' backs. However, many law enforcement agencies and departments are small, consisting of only a few LEOs, making partnering of LEOs unfeasible. Standard dispatch protocols, and training for dispatchers to identify calls for service that may have increased risk for LEO assault, should be established. Best practices can be developed by companies that design software to aid in law enforcement dispatch with support from law enforcement unions and the International Association of Chiefs of Police. Potentially dangerous situations and encounters may be mitigated if backup can arrive before a LEO responds to a call or encounters a suspect.

Firearm use by suspects/criminals represents a significant occupational hazard to law enforcement. Handguns remain the most common type of firearms used against LEOs in assaults. Permit-to-purchase handgun licensing laws (PTP) make it more difficult for prohibited persons to purchase handguns. These laws require some form of interaction with law enforcement and a background check prior to the issuing of a permit for a handgun purchase. Sellers, both licensed and private, may only sell to a purchaser with a valid permit. These interactions with law enforcement and background checks for all handgun sales have the potential to increase scrutiny on purchasers making it more difficult for prohibited persons to obtain a handgun. With a lack of federal legislation mandating background checks for all sales, state legislators wanting to address this issue

could consider PTP legislation. Missouri's 2007 repeal of its PTP legislation illustrates how a change in laws governing the legal gun market can drastically impact LEO safety, leading to an increased risk of LEOs being shot in the line-of-duty.

This dissertation demonstrates the importance of examining nonfatal assaults, as well as LEO homicide, to gain the most complete picture of LEO safety. The LEOKA database should collect detailed data on all nonfatal assaults with injury, not just those committed with a knife/cutting instrument or firearm. Assaults with personal weapons (e.g. fists or feet) may not have the same lethal potential as assaults with firearms or knives, however, these assaults could represent an important piece of LEO occupational safety that is currently being missed. Additionally, it would be beneficial for the LEOKA database to include data on the rating or style of body armor used by LEOs as well as the type of ammunition used by suspects when available. These variables would aid in understanding the role of firearms and body armor in LEO assaults.

Priorities for Future Research

Future research on the occupational assault of LEOs should focus on three main areas. First, other potentially relevant policies should be identified and evaluated for an impact on LEO safety. State-level policies related to crime and firearms are likely to influence the environment in which LEOs work. In particular, states with policies requiring universal background checks for all sales that are not considered PTP laws should be evaluated. State-level crime and firearm policies affect the risk of occupational assault among LEOs, the risks and potential benefits of these policies warrant evaluation. Additionally, local level policies for policing strategies, such as hot spots policing or

focused deterrence, should be evaluated. Since fatal assaults are a rare event, a focus on nonfatal assault outcomes would be beneficial for these evaluations.

Second, it has been more than thirty years since Margarita assessed why suspects kill LEOs.³¹ At the time, it was found that LEOs were often killed in the heat of the moment as suspects attempted to evade capture. This research occurred prior to the popularity of three strikes laws as a deterrent to repeat offenders committing serious crime. In manuscript three there was an association between three strikes laws and fatal LEO assaults that was statistically significant. What is not known is if the suspects fatally assaulting LEOs in the study were at risk of receiving a third strike and potential life imprisonment.

A renewed investigation into the context of why suspects kill LEOs could help elucidate the relationship between three strikes laws and fatal assaults. Alternatively, an updated look at these contexts could identify new factors that are influencing why suspects fatally assault LEOs and what role anti-social and/or anti-governmental attitudes have in ambush and unprovoked attacks of LEOs. Additionally, the situational factors that were identified in manuscript one should be examined to determine if any independently predict fatal outcomes in order to better inform jurisdiction level policies.

Third, in order to understand why LEOs do not wear body armor despite the evidence of its effectiveness, it is essential to identify barriers to body armor use. It could be that a LEO's jurisdiction does not offer body armor, LEOs may not perceive themselves to be at risk of assault or injury, or LEOs may feel that body armor is too uncomfortable or cumbersome to wear. Engaging LEOs through focus groups and surveys would identify potential barriers that could be addressed through education or

redesign of body armor technology to increase use. An examination of the types of body armor used by LEOs and the type of ammunition used by suspects would also help to gain a greater understanding of how LEO body armor is circumvented.

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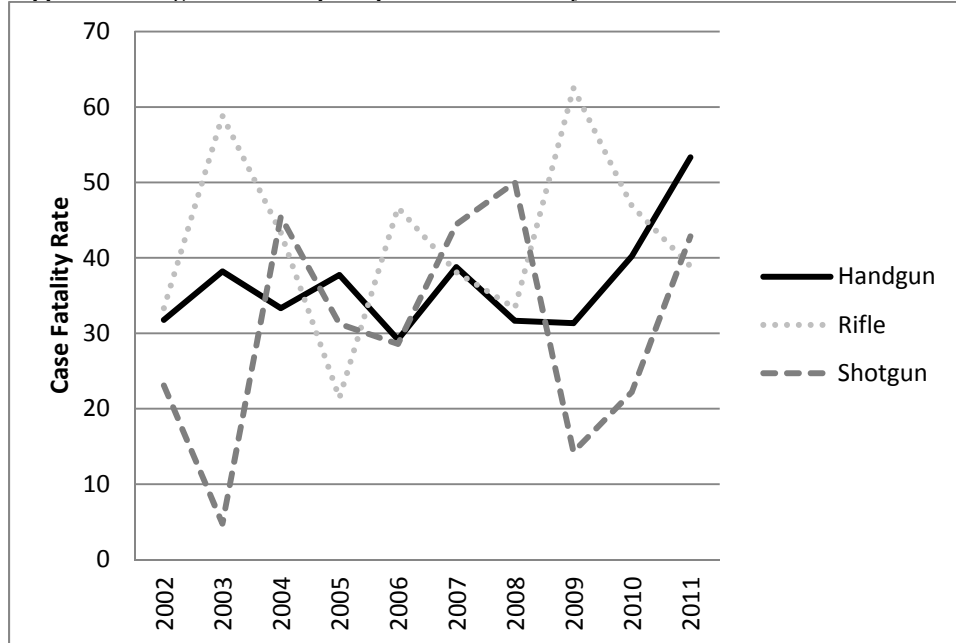
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Appendices

Manuscript One

Supplemental Figure 2.1: Weapon Specific Case Fatality Rates in Law Enforcement Officer Assaults, 2002-2011



Law Enforcement Officers Killed and Assaulted Database

The main source of data on the dependent variables in this study was the Law Enforcement Officers Killed and Assaulted (LEOKA) database. The Federal Bureau of Investigation compiles this database from reports of every on-duty fatal and nonfatal LEO assault that occurs in the U.S. each year.² Collection of nonfatal assault data is restricted to assaults with a knife/cutting instrument or firearm that results in an injury and collection began in 2002. The LEOKA database is part of the Uniform Crime Reporting program (UCR) where states report information and statistics on crime, arrests, and homicide to the FBI each year;² certain reporting criteria must be met to ensure data are accurate and standardized across states. However, even with reporting criteria there are occasional fields that are missing data, particularly in fields requiring more detailed

data such as the make or model of a firearm. The LEOKA database is publicly available through the FBI. The database includes a variety of variables including LEO age, experience, race, and gender; the type of assignment a LEO was on and the type of call to which he/she was responding; distance from the suspect and suspects' weapon; whether back up was present and if LEOs were wearing body armor.

Compared to other potential sources of data for LEO assaults, the LEOKA has the potential to miss or undercount LEO assaults due to the FBI's strict definition of "line-of-duty." However, this database provides the most detailed data for fatal assaults and is the only source for data on nonfatal LEO assaults that captures data for all states.

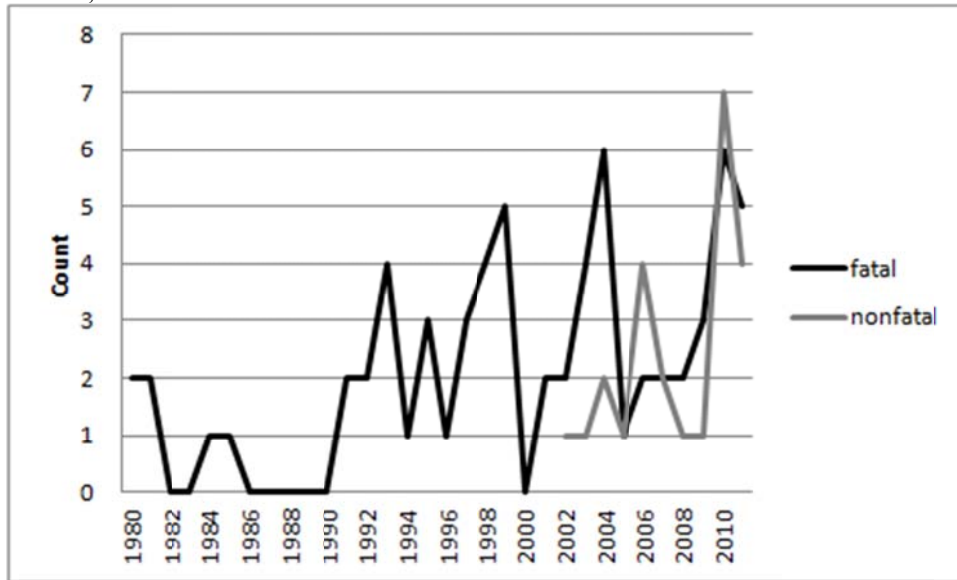
The categorizations used in analyses are those provided by the LEOKA database, and used as presented whenever possible. The only additional categorization made was for encounter. Two categories of traffic stop were provided in the database; these were collapsed into one traffic stop category. Additionally, investigations and investigative activities were also combined due to overlap in the categories and the nature of the analyses which was to provide the general context of types of encounters during which LEOs were assaulted.

Manuscript Two

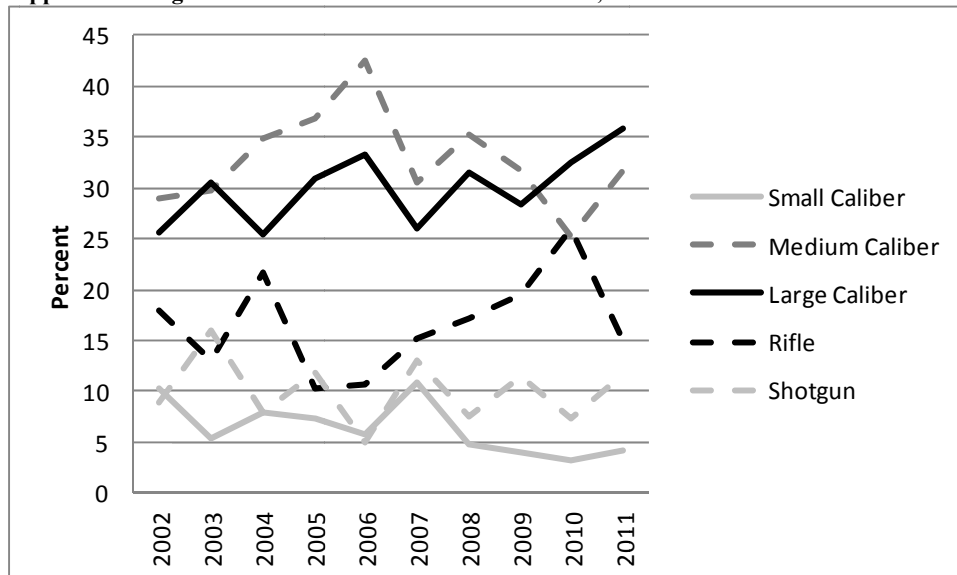
Supplemental Table 3.1: Assault Outcome of Threshold Exceeding Vest Penetrations, 2002-2011

Exceeded Threshold	Fatal (%)	Nonfatal (%)
Yes	58	32
No	38	62

Supplemental Figure 3.1: Number of Threshold Exceeding Vest Penetrations in Law Enforcement Officer Assaults, 1980-2011



Supplemental Figure 3.2: Firearm Use in Overall Assaults, 2002 – 2011



Handgun Caliber

Handguns were classified as small, medium, or large caliber handguns. Small caliber handguns were defined as .22, .25, and .32 calibers. Medium caliber handguns as .38, .380, and 9 mm calibers. Large caliber handguns were defined as .357, .40, .41, .44, .45, .50, and 10 mm calibers. Caliber is determined by the diameter of the bullet, with small caliber handguns firing the smallest bullets. The classification of handgun caliber is not solely a research tool, law enforcement and firearm sales/manufacturing use caliber to generally distinguish between the sizes of bullets a handgun fires. Previous studies have also used this classification when conducting research on firearms as a way to increase the sample for a given handgun category rather than using each individual firearm's caliber.

Manuscript Three

Supplemental Table 4.1: Model Specifications Negative Binomial Regression Models for Fatal Assaults – All Methods, 1984 – 2010

Model*	1	2	3	4	5	6	7
RTC	0.88	0.77	1.04	0.98	1.07	1.08	--
Three Strikes	0.97	0.88	1.08	1.24	1.27	1.38	--
PTP	0.90	0.89	0.98	0.82	1.01	1.02	--
Theoretically mandatory variables: Number of LEOs, state spending on crime control, arrest rate for violent crime		X	X	X	X	X	X
Optional Independent Variables 1: Unemployment, incarceration, percent poverty, percent MSA			X		X	X	X
Optional Independent Variables 2: Percent Black, percent Hispanic, percent age 18-35, gun availability				X	X	X	X
Year dummies						X	X
State-Year dummies							X
AIC	2924	2845	2754	2758	2685	2722	--
BIC	2945	1876	2805	2810	2757	2927	--
Number of Observations	1323	1284	1254	1266	1236	1236	--
Log likelihood	-1458	-1416	-1367	-1369	-1328	-1321	--

*All models include state fixed effects

Bold indicates significance at $p < 0.05$

-- indicates the model did not converge

Supplemental Table 4.2: Model Specifications Negative Binomial Regression Models for Fatal Assaults – Handguns Only, 1984 – 2010

Model*	1	2	3	4	5	6	7
RTC	0.82	0.69	0.94	0.88	0.98	0.99	--
Three Strikes	0.94	0.84	1.03	1.18	1.19	1.28	--
PTP	0.63	0.64	0.70	0.67	0.65	0.51	--
Number of LEOs, state spending on crime control, arrest rate for violent crime		X	X	X	X	X	X
Unemployment, incarceration, percent poverty, percent MSA			X		X	X	X
Percent Black, percent Hispanic, percent age 18-35, gun availability				X	X	X	X
Year dummies						X	X
State-Year dummies							X
AIC	2312	2253	2179	2181	2119	2141	--
BIC	2333	2284	2230	2232	2190	2345	--
Number of Observations	1296	1257	1227	1239	1209	1209	--
Log likelihood	-1152	-1120	-1079	-1080	-1045	-1030	--

*All models include state fixed effects

Bold indicates significance at $p < 0.05$

-- indicates the model did not converge

Supplemental Table 4.3: Model Specifications Negative Binomial Regression Models for Fatal Assaults – Non-Handguns, 1984 – 2010

Model*	1	2	3	4	5	6	7
RTC	0.85	--	1.19	1.15	1.26	--	--
Three Strikes	1.24	--	1.44	1.70	1.79	--	--
PTP	5.42	--	5.01	7.32	4.33	--	--
Number of LEOs, state spending on crime control, arrest rate for violent crime		X	X	X	X	X	X
Unemployment, incarceration, percent poverty, percent MSA			X		X	X	X
Percent Black, percent Hispanic, percent age 18-35, gun availability				X	X	X	X
Year dummies						X	X
State-Year dummies							X
AIC	1425	--	1351	1350	1320	--	--
BIC	1446	--	1401	1400	1391	--	--
Number of Observations	1242	--	1173	1185	1155	--	--
Log likelihood	-708	--	-665	-665	-646	--	--

*All models include state fixed effects

Bold indicates significance at $p < 0.05$

-- indicates the model did not converge

Supplemental Table 4.4: Model Specifications Negative Binomial Regression Models for Overall Assaults – All Methods, 2002 – 2010

Model*	1	2	3	4	5	6	7
RTC	0.90	1.08	0.97	1.17	1.02	0.89	--
PTP Repeal	1.19	1.17	1.34	1.20	1.28	1.5	--
Number of LEOs, state spending on crime control, arrest rate for violent crime		X	X	X	X	X	X
Unemployment, incarceration, percent poverty, percent MSA			X		X	X	X
Percent Black, percent Hispanic, percent age 18-35, gun availability				X	X	X	X
Year dummies						X	X
State-Year dummies							X
AIC	1324	1313	1261	1269	1222	1228	--
BIC	1337	1333	1297	1305	1274	1312	--
Number of Observations	423	418	406	409	397	397	--
Log likelihood	-659	-651	-621	-625	-598	-593	--

*All models include state fixed effects

Bold indicates significance at $p < 0.05$

-- indicates the model did not converge

Supplemental Table 4.5: Model Specifications Negative Binomial Regression Models for Overall Assaults – Handguns Only, 2002 – 2010

Model*	1	2	3	4	5	6	7
RTC	0.94	1.16	1.07	1.27	1.15	0.95	--
PTP Repeal	1.46	1.37	1.67	1.44	1.63	2.13	--
Number of LEOs, state spending on crime control, arrest rate for violent crime		X	X	X	X	X	X
Unemployment, incarceration, percent poverty, percent MSA			X		X	X	X
Percent Black, percent Hispanic, percent age 18-35, gun availability				X	X	X	X
Year dummies						X	X
State-Year dummies							X
AIC	1020	1015	983	982	954	958	--
BIC	1032	1035	1019	1018	1006	1042	--
Number of Observations	414	409	397	400	388	388	--
Log likelihood	-507	-502	-482	-482	-464	-458	--

*All models include state fixed effects

Bold indicates significance at $p < 0.05$

-- indicates the model did not converge

Supplemental Table 4.6: Model Specifications Negative Binomial Regression Models for Overall Assaults – Non-Handguns, 2002 – 2010

Model*	1	2	3	4	5	6	7
RTC	0.88	0.96	1.06	0.92	0.99	0.97	--
PTP Repeal	0.98	0.87	1.03	1.06	0.99	1.03	--
Number of LEOs, state spending on crime control, arrest rate for violent crime		X	X	X	X	X	X
Unemployment, incarceration, percent poverty, percent MSA			X		X	X	X
Percent Black, percent Hispanic, percent age 18-35, gun availability				X	X	X	X
Year dummies						X	X
State-Year dummies							X
AIC	930	916	894	882	865	871	--
BIC	942	939	929	917	915	952	--
Number of Observations	378	373	361	364	352	352	--
Log likelihood	-462	-452	-438	-432	-419	-414	--

*All models include state fixed effects

Bold indicates significance at $p < 0.05$

-- indicates the model did not converge

Supplemental Table 4.7: Primary Model Results of Poisson Regression for Fatal Assaults, 1984 – 2010

Dependent Variable	IRR^a	95% CI^b	p-value
<i>RTC</i>			
Total	1.04	0.83 to 1.30	0.741
Handgun	0.98	0.75 to 1.29	0.894
Non-Handgun	1.17	0.76 to 1.81	0.467
<i>Three Strikes</i>			
Total	1.35	1.08 to 1.68	0.007
Handgun	1.27	0.97 to 1.66	0.086
Non-Handgun	1.84	1.19 to 2.85	0.006
<i>PTP</i>			
Total	0.93	0.36 to 2.43	0.886
Handgun	0.52	0.186 to 1.48	0.221
Non-Handgun	4.70	-- to --	0.984

^aIncident Rate Ratio Estimated from Poisson Regression.

^bConfidence Interval of the estimated IRR.

Supplemental Table 4.8: Primary Model Results of Poisson Regression for Nonfatal Assaults, 2002 – 2010

Dependent Variable	IRR^a	95% CI^b	p-value
<i>RTC</i>			
Total	0.96	0.53 to 1.74	0.888
Handgun	0.87	0.39 to 1.94	0.727
Non-Handgun	1.02	0.42 to 2.52	0.961
<i>Missouri's PTP Repeal</i>			
Total	2.27	1.16 to 4.42	0.017
Handgun	3.70	1.45 to 9.46	0.006
Non-Handgun	1.36	0.52 to 3.59	0.534

^aIncident Rate Ratio Estimated from Poisson Regression.

^bConfidence Interval of the estimated IRR.

Supplemental Table 4.9: Primary Model Results of Poisson Regression for Overall Assaults, 2002 – 2010

Dependent Variable	IRR ^a	95% CI ^b	p-value
<i>RTC</i>			
Total	0.97	0.58 to 1.63	0.916
Handgun	0.95	0.50 to 1.82	0.883
Non-Handgun	1.03	0.44 to 2.40	0.941
<i>Missouri's PTP Repeal</i>			
Total	1.69	0.923 to 3.10	0.089
Handgun	2.38	1.08 to 5.27	0.032
Non-Handgun	1.05	0.40 to 2.71	0.927

^aIncident Rate Ratio Estimated from Poisson Regression.^bConfidence Interval of the estimated IRR.**Supplemental Table 4.10: Negative Binomial Primary Model Full Results for Fatal Assaults**

Outcome	Explanatory Variable	IRR ^a	S.E. ^b	p-value
Total Assaults	RTC Law	1.08	0.134	0.514
	Three Strikes Law	1.35	0.164	0.015
	PTP Law	1.10	0.50	0.835
	LEO Expenditures	0.95	0.127	0.713
	Violent Crime Arrest Rate	1.00	0.001	0.440
	Percent Poverty	1.01	0.02	0.474
	Percent MSA	0.99	0.006	0.086
	Gun Availability	0.61	0.69	0.664
Handgun Assaults	RTC Law	0.98	0.139	0.896
	Three Strikes Law	1.26	0.175	0.099
	PTP Law	0.56	0.31	0.290
	LEO Expenditures	1.05	0.169	0.756
	Violent Crime Arrest Rate	1.00	0.001	0.956
	Percent Poverty	1.03	0.02	0.154
	Percent MSA	1.00	0.009	0.808
	Gun Availability	0.91	1.26	0.945

^aIncident Rate Ratio Estimated from Negative Binomial Regression.^bStandard Error

Supplemental Table 4.11: Negative Binomial Primary Model Full Results for Nonfatal Assaults

Outcome	Explanatory Variable	IRR^a	S.E. ^b	p-value
Nonfatal Assaults	RTC Law	0.78	0.241	0.419
	PTP Repeal	2.27	0.897	0.039
	LEO Expenditures	0.67	0.096	0.006
	Violent Crime Arrest Rate	1.00	0.002	0.038
	Percent Poverty	0.98	0.036	0.541
	Percent MSA	0.97	0.15	0.046
	Gun Availability	1.23	1.99	0.896
Nonfatal Handgun Assaults	RTC Law	0.73	0.300	0.411
	PTP Repeal	3.25	1.79	0.033
	LEO Expenditures	0.70	0.144	0.083
	Violent Crime Arrest Rate	1.00	0.003	0.084
	Percent Poverty	0.91	0.046	0.058
	Percent MSA	0.99	0.21	0.535
	Gun Availability	23.66	52.73	0.156
Nonfatal Not Handgun Assaults	RTC Law	0.92	0.417	0.850
	PTP Repeal	1.45	0.759	0.477
	LEO Expenditures	0.68	0.117	0.024
	Violent Crime Arrest Rate	1.00	0.003	0.068
	Percent Poverty	1.05	0.051	0.297
	Percent MSA	0.98	0.026	0.450
	Gun Availability	0.05	0.109	0.171

^aIncident Rate Ratio Estimated from Negative Binomial Regression.^bStandard Error

Supplemental Table 4.12: Negative Binomial Primary Model Full Results for Overall Assaults

Outcome	Explanatory Variable	IRR^a	S.E. ^b	p-value
Total Assaults	RTC Law	0.93	0.253	0.778
	PTP Repeal	1.51	0.598	0.300
	LEO Expenditures	0.75	0.095	0.021
	Violent Crime Arrest Rate	1.00	0.001	0.559
	Percent Poverty	1.036	0.032	0.261
	Percent MSA	0.98	0.012	0.185
	Gun Availability	1.04	1.42	0.979
Handgun Assaults	RTC Law	1.01	0.346	0.971
	PTP Repeal	2.03	0.954	0.132
	LEO Expenditures	0.842	0.138	0.298
	Violent Crime Arrest Rate	1.00	0.002	0.529
	Percent Poverty	1.00	0.039	0.937
	Percent MSA	1.00	0.018	0.847
	Gun Availability	2.67	4.75	0.580
Non-Handgun Assaults	RTC Law	0.92	0.370	0.836
	PTP Repeal	1.14	0.631	0.807
	LEO Expenditures	0.70	0.117	0.035
	Violent Crime Arrest Rate	1.00	0.002	0.433
	Percent Poverty	1.05	0.048	0.292
	Percent MSA	0.99	0.017	0.478
	Gun Availability	0.067	0.131	0.166

^aIncident Rate Ratio Estimated from Negative Binomial Regression.^bStandard Error

Supplemental Table 4.13: Poisson Regression Primary Model Full Results for Fatal Assaults

Outcome	Explanatory Variable	IRR^a	S.E. ^b	p-value
Total Assaults	RTC Law	1.04	0.119	0.741
	Three Strikes Law	1.35	0.151	0.007
	PTP Law	0.932	0.457	0.886
	LEO Expenditures	0.89	0.114	0.343
	Violent Crime Arrest Rate	1.00	<0.001	0.538
	Percent Poverty	1.02	0.017	0.33
	Percent MSA	0.99	0.007	0.311
	Gun Availability	0.71	0.789	0.758
Handgun Assaults	RTC Law	0.98	0.138	0.894
	Three Strikes Law	1.27	0.174	0.086
	PTP Law	0.52	0.277	0.221
	LEO Expenditures	1.05	0.168	0.766
	Violent Crime Arrest Rate	1.00	0.001	0.943
	Percent Poverty	1.03	0.021	0.156
	Percent MSA	1.00	0.009	0.908
	Gun Availability	1.02	1.40	0.986
Non-Handgun Assaults	RTC Law	1.17	0.260	0.467
	Three Strikes Law	1.85	0.411	0.006
	PTP Law	4.70	8.52	0.984
	LEO Expenditures	0.68	0.170	0.124
	Violent Crime Arrest Rate	1.00	0.001	0.848
	Percent Poverty	0.99	0.032	0.828
	Percent MSA	0.99	0.013	0.291
	Gun Availability	0.77	1.64	0.902

^aIncident Rate Ratio Estimated from Poisson Regression.^bStandard Error

Supplemental Table 4.14: Poisson Regression Primary Model Full Results for Nonfatal Assaults

Outcome	Explanatory Variable	IRR^a	S.E. ^b	p-value
Nonfatal Assaults	RTC Law	0.96	0.293	0.888
	PTP Repeal	2.27	0.774	0.017
	LEO Expenditures	0.70	0.086	0.004
	Violent Crime Arrest Rate	1.00	0.002	0.004
	Percent Poverty	0.99	0.031	0.862
	Percent MSA	0.96	0.019	0.020
	Gun Availability	2.26	3.60	0.608
Nonfatal Handgun Assaults	RTC Law	0.87	0.356	0.727
	PTP Repeal	3.70	1.77	0.006
	LEO Expenditures	0.71	0.133	0.068
	Violent Crime Arrest Rate	1.01	0.002	0.020
	Percent Poverty	0.93	0.41	0.118
	Percent MSA	0.95	0.024	0.029
	Gun Availability	68.85	157.1	0.064
Nonfatal Not Handgun Assaults	RTC Law	1.02	0.470	0.961
	PTP Repeal	1.36	0.674	0.534
	LEO Expenditures	0.68	0.11	0.018
	Violent Crime Arrest Rate	1.00	0.002	0.074
	Percent Poverty	1.06	0.47	0.194
	Percent MSA	0.97	0.030	0.400
	Gun Availability	0.08	0.191	0.273

^aIncident Rate Ratio Estimated from Poisson Regression.^bStandard Error

Supplemental Table 4.15: Poisson Regression Primary Model Full Results for Overall Assaults

Outcome	Explanatory Variable	IRR^a	S.E. ^b	p-value
Total Assaults	RTC Law	0.97	0.255	0.916
	PTP Repeal	1.69	0.523	0.089
	LEO Expenditures	0.75	0.079	0.006
	Violent Crime Arrest Rate	1.00	0.001	0.152
	Percent Poverty	1.02	0.026	0.391
	Percent MSA	0.97	0.017	0.057
	Gun Availability	2.35	3.16	0.525
Handgun Assaults	RTC Law	0.95	0.314	0.883
	PTP Repeal	2.38	0.964	0.032
	LEO Expenditures	0.79	0.118	0.118
	Violent Crime Arrest Rate	1.00	0.002	0.466
	Percent Poverty	1.00	0.035	0.960
	Percent MSA	0.956	0.021	0.043
	Gun Availability	3.43	6.39	0.508
Non- Handgun Assaults	RTC Law	1.032	0.44	0.941
	PTP Repeal	1.05	0.508	0.927
	LEO Expenditures	0.70	0.105	0.017
	Violent Crime Arrest Rate	1.00	0.002	0.455
	Percent Poverty	1.04	0.041	0.313
	Percent MSA	0.99	0.028	0.603
	Gun Availability	0.50	0.973	0.722

^aIncident Rate Ratio Estimated from Poisson Regression.^bStandard Error

Curriculum Vitae

Cassandra Kercher Crifasi, MPH

624 N. Broadway, Room 588, Baltimore, MD 21205 | ckerche1@jhu.edu

EDUCATION

Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Ph.D. Candidate – Department of Health Policy and Management, expected 2014

Health and Public Policy Track: Specialization in Injury Prevention and Control

Drexel University School of Public Health, Philadelphia, PA

MPH, Environmental and Occupational Health, 2010

Central Washington University, Ellensburg, WA

BS, Biology and minor in Chemistry, 2006

FELLOWSHIPS AND AWARDS

Johns Hopkins Bloomberg School of Public Health

The Alison Snow Jones Prize, 2014

Inaugural Recipient – Susan P. Baker Scholarship in Injury Prevention, 2013 – 2014

National Institute for Occupational Safety and Health Pre-Doctoral Fellowship:

Occupational Injury Epidemiology and Prevention, 2013 – 2014 & 2010 – 2014

National Institute of Child Health and Development Pre-Doctoral Training Fellowship:

Interdisciplinary Research Training on Violence in the Family, 2011 - 2013

Drexel University School of Public Health

Delta Omega Honorary Society in Public Health, 2010

Excellence in Communication, 2010

Dean's Scholarship, 2008 – 2010

Central Washington University

Beta Beta Beta National Biological Honor Society, 2004

RESEARCH EXPERIENCE

Research Assistant, Center for Gun Policy and Research, 2011 – present

- Evaluation of state and local policy changes on homicide and violent crime

Research Assistant to Dr. Keshia Pollack, 2011 – 2013

An analysis of the impacts of Health Impact Assessment on decision making and policy

- Verification of transcripts from key informant interviews
- Development and revision of codebook for qualitative coding

Research Assistant, Center for Injury Research and Policy, 2011 – 2012

“Preventing Injuries in Maryland: A Resource for State Policy Makers”

- Comprehensive literature review on the impacts of Intimate Partner Violence (IPV) nationally and in Maryland
- Analysis of legislation, programs, and interventions to address IPV
- Creation of recommendations to reduce IPV in Maryland

Research Assistant to Dr. Stephen Bowman, 2011 – 2012

“Perceptions of rural EMS providers on pre-hospital care for children”

- Organized and moderated focus groups in rural Washington State and Arkansas
- Explored barriers to pediatric care, gaps in current education and training programs, and strategies for increasing program and training comprehensiveness

Research Assistant, Society for Advancement of Violence and Injury Research Pedestrian Working Group, 2010 – 2011

“Toward environments and policies that promote injury-free active living – it wouldn’t hurt”

- Comprehensive literature review and contributor to peer-reviewed published paper

TEACHING ASSISTANT EXPERIENCE

Johns Hopkins University

Fundamentals of Health Policy and Management, 2012-13 & 2013-14

Instructor: Donald Steinwachs, PhD

Johns Hopkins Bloomberg School of Public Health

Summer Institute in Injury Prevention and Control, 2011-12 & 2013-14

Instructor: Carolyn Fowler, PhD, MPH

Graduate Seminar in Injury Research and Policy, 2011-12, 2012-13 & 2013-14

Instructor: Daniel Webster, ScD, MPH & Keshia Pollack, PhD, MPH

Understanding and Preventing Violence, 2012-13 & 2013-14

Instructor: Daniel Webster, ScD, MPH

Introduction to Health Survey Research Methods, 2012-13

Instructors: Susan Sherman, PhD, MPH & Vivian Go, PhD, MPH

Summer Institute in Health Survey Research Methods, 2012-13
Instructors: Susan Sherman, PhD, MPH & Vivian Go, PhD, MPH

Research and Proposal Writing Process I & II, 2012-13
Instructor: Leiyu Shi, DrPH, MBA, MPA

Health Policy I: Social and Economic Determinants of Health, 2011-12 & 2012-13
Instructor: Thomas LaVeist, PhD

Health Advocacy, 2011-12 & 2012-13
Instructor: Josh Horwitz

Health Impact Assessment, 2011-12 & 2012-13
Instructor: Keshia Pollack, PhD, MPH

Drexel University School of Public Health
Environmental and Occupational Health, 2009-10
Lead Instructor: Hernando Perez, PhD, MPH, CIH, CSP

PEER REVIEW ACTIVITIES

Ad hoc Reviewer for *Injury Prevention*

PEER-REVIEWED PUBLICATIONS

1. Webster, D.W, **Crifasi, C.K.**, Vernick, J.S. Effects of the Repeal of Missouri's Handgun Purchaser Licensing Law on Homicides. *Journal of Urban Health*, March 7. [Epub ahead of print].
2. Swedler, D.I., **Kercher, C.**, Simmons, M.M., Pollack, K.M. Occupational homicide of law enforcement officers in the U.S., 1996-2010. *Injury Prevention*, May 31. [Epub ahead of print].
3. **Kercher, C.**, Swedler, D.I., Pollack, K.M., Webster, D.W. 2013. Homicides of law enforcement officers responding to domestic disturbance calls. *Injury Prevention*, Feb 8. [Epub ahead of print].
4. Pollack, K.M., **Kercher, C.**, Frattaroli, S., Peek-Asa, C., Sleet, D., Rivara, F.P. 2012. Toward environments and policies that promote injury-free active living- it wouldn't hurt. *Health and Place*, 18 (1), 106-114.

DISSERTATION MANUSCRIPTS

1. Occupational Assault of Law Enforcement Officers
2. Exceeding the Threshold: the role of firearms in law enforcement assault and circumvention of body armor
3. State Policy Changes and Law Enforcement Officer Assaults

MEMBERSHIPS

American Society of Criminology

Society for Advancement of Violence and Injury Research

Delta Omega Honorary Society in Public Health – Beta Omega Chapter

American Public Health Association – Injury Control and Emergency Health Services Section