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FACTORS ASSOCIATED WITH CIVILIAN AND POLICE OFFICER INJURY DURING 10 YEARS OF OFFICER-INVOLVED SHOOTING INCIDENTS: A CROSS-SECTIONAL ANALYSIS

ELLEN PADDOCK
UTHealth School of Public Health, ellen.m.paddock@gmail.com

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by

ELLEN PADDOCK, BA

APPROVED:

Jennifer Reingle

Digitally signed by Jenn
DN: cn=Jenn, o, ou,
email=jennifer.reingle@utsouthwestern.edu, c=US
Date: 2018.11.27 17:56:38 -06'00'

JENNIFER REINGLE GONZALEZ, PHD

Kelley Pettee Gabriel

KELLEY PETTEE GABRIEL, PHD

STEPHEN BISHOPP, PHD

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by

ELLEN PADDOCK
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Ellen Paddock, MPH
The University of Texas
School of Public Health, 2018

Thesis Committee: Jennifer Gonzalez, PhD, Kelley Gabriel, PhD, Stephen Bishopp, PhD

ABSTRACT

Purpose. Law enforcement officer-involved shootings are uncommon events in the context of encounters with the public, but extreme situations which have the potential to pose immense harm to individuals and communities. Previous research demonstrates that a large proportion of such incidents result in injury or death, most commonly to civilians, but in some cases to officers as well. However, there has been little study of what factors are associated with injury during such incidents, and whether these factors might differ for civilians compared to officers. This study examined the factors associated with both civilian and officer injury and/or fatality during officer-involved shooting incidents, to better understand how harm might be reduced in the most extreme law enforcement scenarios.

Methods. Secondary analysis was conducted on a sample of 281 officers involved in 177 unique shooting incidents recorded by Dallas Police Department between 2005-2015. Bivariate logistic regression and multivariable generalized estimation equation (GEE) models were used to examine the unadjusted and adjusted association of multiple officer, civilian, and situational characteristics with both civilian injury or fatality, and officer injury or fatality.

Results. Civilian injury or fatality occurred in 61.02% of unique incidents, and officer injury in 13.56% of unique incidents. A majority (79.19%) of OIS incidents involved black or Hispanic/Latino/a civilians, but odds of injury were lower for black (AOR= .21, 95% CI .06-.72, p=.013) and Hispanic/Latina/o (AOR=.22, 95% CI .07-.72, p=.012) civilians compared to white when controlling for officer race, officer job assignment, presence of a weapon, and time of day. Civilians also had higher odds of injury during the daytime, though a majority of incidents occurred at night. Officer injury was significantly associated with job role, with patrol officers having lower adjusted odds of injury compared to administrative officers during the course of an OIS incident (AOR=.19, 95% CI .04-.89, p=.036).

Conclusions and Public Health Relevance. Results may help inform future law enforcement training by identifying characteristics in high-intensity situations that most strongly predict bodily harm to a community member and/or officer. Future studies should seek to further elucidate the factors that influence injury during the course of a shooting and assess whether the findings in this study are replicated in other jurisdictions.

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Introduction

In the continuum of encounters that law enforcement officers may have with local residents, officer-involved shootings (OIS) represent the most extreme. In a national survey of law enforcement agencies querying use of force policies across the United States (U.S.), Smith et al. (2010) found that firearms were ranked as the highest level of force an officer could possibly use, with 100% of responding agencies requiring higher-level review of any intentional discharge of a firearm at another person.[1] These policies do not occur in a vacuum. The past four decades have been characterized by waves of public scrutiny of OIS, precipitated by high-profile incidents and racial disparities in the use of force.[2,3] More recently, the lack of reliable national reporting data for fatal shootings has also taken center stage after independent media outlets and crowdsourced data collection websites have identified significant gaps in existing national data.[3-7] Since that time, multiple peer-reviewed articles have examined the validity of data collected by media outlets and crowdsourced sites,[8,9] and quantify the degree of under-reporting for official datasets such as the Centers for Disease Control and Prevention's National Vital Statistics System, the Federal Bureau of Investigation's Uniformed Crime Reporting (UCR) Supplemental Homicide Reports, and Bureau of Justice Statistics' Arrest-Related Deaths program,[4,10,11] with one study estimating that federal sources missed as many as half of shooting cases in some years, likely due to underreporting and varying case definitions.[10]

As a result of these challenges, estimates of the prevalence of OIS vary widely, with 2016 counts ranging from 549 “justifiable homicides” reported in the UCR[12] to 1,129 “police killings” from the crowdsourced project Mapping Police Violence.[13] Yet as notoriously difficult as it is to quantify *fatal* OIS incidents, data on nonfatal shootings—including injuries, missed shots, and unintentional shootings—are even more difficult to accurately quantify, as there are no national databases or consistent reporting requirements regarding nonfatal shootings.[7,10] One of the few available count estimates comes from Miller and colleagues (2016), who cross-referenced multiple data sources to estimate that in 2012, 2,670 individuals reported to the emergency room, were admitted to a hospital, or killed as a result of injuries incurred during law enforcement encounters. However, the article notes that these data are flawed due to inconsistent reporting by emergency departments and unavailability of ICD-10 codes that specify the presence of legal interventions as a cause of the traumatic injury incurred.[14]

Use of Force & Injury

U.S.[15] and international[16] standards hold that firearms should be used as a last resort under immediate and serious threat of injury or death, though policies may be inconsistent across states and jurisdictions.[17] Such standards are essential given research showing that, of all forms of force an officer may use, firearms are the most fatal.[14,18,19] Indeed, in a recent study of documented death or hospital-treated injuries that were attributed to law enforcement encounters, firearms accounted for 22.7% of all law enforcement-related hospital admissions and 95% of fatalities.[14] The only other form of force associated with fatalities were TASERs, and a single death from a blunt object. The fatality rate for all firearm cases in the same study was 38% compared to 2.8% for tasers.[14]

Injury During OIS Incidents

Although detailed injury data resulting from OIS incidents is extremely limited, existing evidence—primarily case studies and annual reports from large municipal law enforcement agencies—suggest that a majority of injuries and deaths incurred during such events are to civilians rather than officers.[20-23] Yet law enforcement officers are also at risk for injury in such incidents, which are often highly stressful, volatile, and/or confusing, requiring officers to make life-or-death decisions in seconds with limited information about the context of the on-going incident. Potential hazards include not only resistance or force from the person they are confronting, but also friendly fire, physical or environmental hazards (e.g. vehicles, chemical hazards[21]), and even psychological factors such as an officer making mistakes due to anxiety.[21,24]

Though OIS incidents are often studied and explained in the context of resistance by the person officers are confronting, data on this point are complex and somewhat conflicting. For example, in a detailed analysis of OIS incidents in Philadelphia from 1987 through 1994, White (2006) found that the although a majority of incidents reported "defending self or others" as the primary reason for shooting (73.4% of non-injurious, 88.3% of injurious, and 97.4% of fatal incidents), suspects were reported as fighting or attacking in only 43.2% of non-injurious shootings, 47.9% of injurious shootings, and 76.3% of injurious shootings.[25] The complex ways that OIS incidents may be hazardous to officers—including but not limited to resistance—is illustrated anecdotally by data from the New York Police

Department's 2016 annual use of force report. The report notes that of 13 officers injured during "intentional discharge- adversarial conflict" incidents, 4 were struck by bullets from a civilian, 4 by bullets from another officer, 3 from lacerations, 1 abrasion/contusions, and 1 chemical injury. The report did "not account for injuries and/or symptoms related to tinnitus, which often results from discharge incidents."[21] **These findings are included to demonstrate that while civilians and officers both face risk of injury or death during OIS incidents, it is possible that both the level and nature of risk may be very different for the two groups**, but that more comprehensive studies are needed to investigate this topic.

Previous Literature on OIS

To date, research on OIS has focused primarily on the factors associated with OIS involvement, rather than outcomes of such incidents. As a result, a substantial body of research has identified officer, victim, and situational characteristics associated with the occurrence of OIS. These findings indicate, for example, that officers with less experience and lower rank and education are more likely to be involved in use of force incidents and/or OIS;[26-32] that people who are young, Black, and/or male are most at risk of being subjected to force or shot;[31,33,34] and that incidents are generally more likely to occur in areas with higher violent crime.[2]

However, existing research falls short in a number of areas. First, previous studies have focused primarily on fatal incidents, with far less research on nonfatal encounters, due in part to the data limitations noted above.[7] Of the small number of studies that have examined injury patterns in OIS incidents, most are decades old, and descriptive rather than analytic studies.

Descriptive Epidemiology of Officer-Involved Shootings

In the first of a two-volume report on OIS in Chicago between 1974-1978, Geller and Karales (1981) found of 509 incidents with valid civilian injury data; 379 (74%) resulted in injury and 130 (26%) in death. Cross-tabulations of reasons for shooting with OIS injury outcome indicated that 32% of fatalities occurred when there was a gun use or threat, 31% when there was use or threat of another deadly weapon or physical force, and 33% for another reason. Ten percent of all shots were accidental.[35] Based on 107 shootings from "a large Sheriff's Department in west central Florida" from 1985-1995, Fitzgerald (1998) found that 49 (46%) shootings were intentional at a person while 31% were accidental and 23% at animals. Of the 49 shots at people, 19 (44.2%) were misses and 24 (55.8%) struck a person, including 9 fatalities (18% of shots at a person, or 37.5% of hits).[36] Similar descriptive results have been reported by Donahue (1991) regarding intentional firearm discharges in Detroit between September 1976 and August 1981. Of 930 such discharges, 682 (73%) did not hit a person, while 166 (18%) resulted in injury and 82 (9%) in death. Descriptive results indicated that missed shot and injury cases generally had similar characteristics, while a higher proportion of fatal cases reported that the civilian had a weapon, assaulted an officer, and had prior charges, convictions, and/or prison sentences.[37] A more recent study by Strote and colleagues (2010) observed that although use of firearms was extremely rare, it was the only type of force in the study sample that caused fatal injuries.[38] Finally, Miller and colleagues' 2016 ecologic study, referenced above, described hospital admission and fatality rates for hospital-treated cases of firearm and other injuries following law enforcement encounters.[14] Notably, some studies have focused and/or reported in the context of "hits" and "misses" rather than injury per se.[25] Yet while other forms of force may theoretically be applied with no physical injury, a “hit” with a bullet is virtually synonymous with at least minor injury, and has high potential for much more serious harm or death.[14]

Analytic Epidemiology of Officer-Involved Shootings

Only two studies were located that analytically assessed factors related to OIS outcomes. White (2006) found that five factors predicted fatality versus a missed shot or injury in multivariate regression models: (1) the officer and civilian were less than 10 feet apart, (2) the incident occurred in the afternoon, (3) the reason for shooting was to defend life, (4) the civilian was perceived as attacking, fighting, or resisting an officer, and (5) the shooting occurred in “an alley or rear yard.”[25] The study also examined predictors of missed shots, finding that misses were statistically significantly associated with: (1) the officer and civilian struggling, (2) shot fired from a distance of greater than 20 feet, (3) non-burglary calls, (4) officer not calling for backup, (5) use of deadly force by only one officer, and (6) subsequent determination that the discharge had violated department policy. Smith et al. (2010) examined the use of force in multiple law enforcement agencies, one of which included firearm use data. While results of actually discharging a firearm were not included due to the small number of cases, *pointing* a gun (but not shooting) was observed to have a protective but non-statistically significant association with officer injury, and a significant protective effect on civilian injury [odds ratio=0.181, p=.001 (NB: confidence interval not reported with the measure of association)]; a finding that officers attributed to the gun ending resistance in most situations.[1] **However, no studies were identified that assessed risk**

factors for injury and fatality during OIS incidents, or factors associated with outcomes for both civilians and officers.

The present study seeks to fill an important research gap by evaluating the factors associated with both civilian and law enforcement officer injuries and fatalities during officer-involved shooting incidents. Using a dataset of 281 OIS incidents reported to Dallas Police Department between 2005-2015.[32] Findings have several important potential implications for public health, described below.

Public Health Significance

Officer-involved shootings are uncommon in law enforcement encounters with the public, but can exact immense physical, mental, social, and economic costs on the individuals and communities involved. For a person injured or killed—whether civilian or officer—there is the immediate physical trauma or loss, as well as what may be a brutal and costly recovery process. One study of patient outcomes for 7,573 general gunshot cases treated in hospitals (not necessarily law enforcement related) estimated that average length of hospital stay was 6 days, with a high of 323 days.[39] More than 60% of injured individuals underwent two or more surgical procedures, and a significant proportion were discharged to short term hospitalization (3.7%), a skilled nursing facility (0.8%), intermediate care facility (0.3%), other facility (6.8%), or home health care (4.8%).[39] Long-term functional outcomes varied by the site of the wound but included physical and mental disabilities.[40] These impact of gunshot wounds on the human body was more vividly illustrated by a 2017 profile of Temple University Hospital's trauma unit, which treated a large number of firearm injury cases in Philadelphia, PA:

“The main thing people get wrong when they imagine being shot is that they think the bullet itself is the problem. The lump of metal lodged in the body. […] This is not trauma surgery. Trauma surgery is about fixing the damage the bullet causes as it rips through muscle and vessel and organ and bone…. The price of survival is often lasting disability. Some patients, often young guys, wind up carrying around colostomy bags for the rest of their lives […] ‘They’re so angry,” Goldberg said. “They should be angry.’ Some are paralyzed by bullets that sever the spinal column. Some lose limbs entirely. During trauma surgery, when the blood flow is redirected to the brain and heart by an aortic clamp, blood goes away from other areas, and tissue in the lower extremities can die, causing gangrene, in which case surgeons must amputate the leg at higher and higher points.”

Long hospital stays, the necessity of multiple and/or complex procedures to prevent death or long-term disability, as well as subsequent rehabilitative costs, mean that gunshot wounds also place an enormous economic burden on the healthcare system. Multiple studies have attempted to identify the costs of such injuries and who the responsible party was for payment (e.g., private insurance, Medicaid, self-pay). Kellermann (1996) found that mean costs per injury ranged from $17,926 for unintentional firearm injuries to $37,769 for legal intervention injuries, the costliest category.[41] Cook (1999) similarly estimated that the average cost per injury was $17,000.[42] A more recent analysis by Spitzer and colleagues (2017) of patients admitted for firearm-related injuries from 2006-2014 estimated average costs per hospital admission to range from $19,642 for self-pay patients to $30,952 for

Medicaid patients, with total inflation-adjusted "cost of initial hospitalizations" averaging $734.6 million per year.[43] All three studies further noted that these costs fall heavily on taxpayers: in the Kellerman study, just over 50% of patients came from zip codes with median income less than $25,000, and only 25.4% had private insurance or HMO at the time.[41] Cook (1999) estimated that nearly half of costs were paid for by public insurance,[42] while Spitzer and colleagues (2017) placed this proportion at approximately one third.[43]

While these results are not specific to victims of OIS, decades of research find that both OIS and violent crime are heavily concentrated in economically disadvantaged communities,[2] suggesting that in addition to the costs of legal intervention shootings being among the highest for firearm injuries,[41] these costs are often paid for using public resources. In many cases, municipalities may also face the costs of legal procedures or settlements to civilian victims and their families,[44] or of absenteeism and workers compensation for injured officers.[45] Though not addressed in this study, it is also critical to note that regardless of physical injury status, both officers and community members involved in OIS incidents are also vulnerable to subsequent mental trauma and long-term effects, including PTSD.[46-48]

Finally, there are also more diffuse costs to health and safety efforts, as a single OIS incident or high-profile use of force can have immense implications for the degree to which residents—particularly those in communities that experience higher levels of crime and policing—feel safe calling law enforcement or willing to participate in public safety efforts. In addition to the more abstract damage to perceived law enforcement legitimacy,[49] this can translate to measurable impacts. For example, one study from 2016 showed that, controlling for crime and previous call patterns, the occurrence of a high-profile use of force case was associated with a reduction of over 20,000 fewer calls for service, with the effect persisting for over a year.[50]

This analysis has the potential to further the understanding of and identify opportunities to reduce potential for injury in high-intensity law enforcement situations. To date, a majority of research has focused on factors leading up to a shooting incident, assessing when, where and to whom OIS incidents are most likely to occur in the first place. However, a critical and understudied piece of this puzzle is understanding what factors *during* an incident influence if and to whom injury occurs. The present study will contribute important epidemiological knowledge and generate hypotheses for future studies regarding officer-involved shootings, and may additionally have important implications for law enforcement de-escalation or use of force trainings, by identifying factors in critical incident situations that are most strongly associated with injury and opportunities to minimize potential for harm.

Conclusion

This study will investigate risk factors for injury and fatality of officers and civilians who were involved in an officer-involved shooting. By doing so, this study seeks to identify the factors in an already-escalated situation that determine whether and who becomes injured. These questions have immense public health implications to the extent that citizen safety from violence, healthcare costs, and confidence in the legal authorities tasked with preventing violence, are issues of public health concern. Additionally, this study may have important findings for the occupational safety of law enforcement officers, particularly in high stress situations.

Research Purpose and Objectives

The purpose of this study is to explore characteristics of law enforcement officer-involved shooting (OIS) incidents to identify factors associated with (a) civilian injury and (b) officer injury in such incidents. Using a sample of OIS incidents reported to Dallas Police Department between 2005-2015, the thesis will be structured around the following research objectives:

1. To examine the relationship between situational, officer, and civilian characteristics and odds of civilian injury or death during officer-involved shooting incidents documented by the Dallas Police Department between 2005-2015; and,
2. To examine the relationship between situational, officer, and civilian characteristics and odds of officer injury or death during officer-involved shooting incidents documented by the Dallas Police Department between 2005-2015.

For each of the 26 predictor-outcome pairs, the following hypotheses will be tested:

H_0: There is no association between predictor variable X (e.g., officer age) and outcome Y (e.g., civilian injury or fatality).

H_{A1}: There is a statistically significant association at $p<0.05$ between predictor variable X (e.g., officer age) and outcome Y (e.g., civilian injury or fatality) in unadjusted logistic regression models.

H_{A2}: There is a statistically significant association at $p<0.05$ between predictor variable X (e.g., officer age) and outcome Y (e.g., civilian injury or fatality), controlling for covariates that reached a significance level of $p<0.25$ in bivariate models.

METHODS

Study Design

This study was a secondary analysis of a dataset previously collected by Dr. Jennifer Gonzalez, Dr. Stephen Bishopp, and colleagues.[32] These data were originally collected as part of a case-control study examining the association between military history and OIS involvement and contain information on 281 shooting officers involved in OIS incidents. These 281 shooting cases were originally frequency-matched on sex at the individual level to 281 controls; however, the current study sample will be limited to the subset of 281 shooting cases. Secondary analyses, described in greater detail below, will be used to assess characteristics of each incident associated with (a) civilian and (b) officer injury or death.

Study Setting and Sample

Officer-level data were obtained for shooting officers on all OIS events documented by the Dallas Police Department (DPD) in Dallas, Texas between January 1, 2005 and December 31, 2015, for a final sample of 281 incidents. Since 2015, DPD has routinely collected data on any incident where a Dallas police officer, on-duty or off-duty, fired their weapon. These firearm discharge data include shootings involving a person, excluding firearm discharges on a firing range or during training. **Therefore, for purposes of this study, an OIS incident refers to any incident in which a Dallas police officer discharged their weapon, on or off duty, in the presence of one or more civilians.**

To compile the dataset, researchers from the University of Texas School of Public Health[32] and the Dallas Police Department abstracted and systematically coded DPD records for each incident to obtain information about situational characteristics and any civilians involved. Additionally, personnel records were used to obtain officer-level characteristics, including military discharge records (DD Form 214) for those officers with prior military experience. Finally, internal affairs records were abstracted to obtain information on any prior allegations of misconduct filed or sustained on an officer.

Measures

Several independent variables were investigated as possible factors associated with civilian and officer injury and/or fatality. When necessary, variables in the original dataset were recoded to facilitate secondary analysis. The final measures for both dependent and independent variables are described below.

Injury and/or Fatality Outcomes. The primary outcomes examined in this analysis were two dichotomous variables: (1) occurrence of any civilian injury and/or fatality, and (2) occurrence of any officer injury and/or fatality, with 1 signifying occurrence of the specified outcome and 0 signifying that the outcome did not occur. For all outcomes, the prefix "any" is used since it is possible that more than one officer or civilian may have been injured in a given incident. For descriptive results only, the specific prevalence of non-fatal injury and fatalities were also calculated; however, due to modest sample size these outcomes were not used in multivariable analysis.

Officer injury outcomes were recorded in the original dataset as a text field labeled "subclassification", which included information on officer, civilian, and bystander injury, as well as shots fired at vehicles and other targets. Injury outcomes for civilians were derived from two variables in the original study dataset: "subclassification" (described above), and a second variable, "subjectinjury," which provided reliable data on injuries to the primary person being confronted by police ("subject") but did not include injuries to bystanders. In order to produce a valid determination about civilian injury outcomes, both variables were cross-tabulated. For any cases with divergent injury reports across the two variables, publicly available incident reports were reviewed to make a final determination. Finally, four civilian injury cases were excluded after review because additional review of publicly available incident reports indicated that the officer did not in fact fire their weapon, or because injury occurred while officers were not present or nearby.

Finally, it important to note that "injury" refers to *any injury* to occur during the course of an entire OIS incident; neither the immediate cause of injury (e.g., gunshot wound vs wound from a vehicle, physical struggle, fall, etc.) nor precise sequence of events (before or after the firearm discharge) can be fully ascertained. Subjective assessment from researchers involved in coding the original data suggests that while civilian injuries were primarily the result of gunshot wounds, officer injuries included a more diverse array of immediate causes, such as injury by a vehicle or physical engagement/use of bodily force. Nevertheless, these qualitative observations cannot be confirmed since the dataset does not contain detailed information on the nature, severity, or precise timing of injury. This remains a limitation of this study and important consideration when interpreting results.

Officer Characteristics. The following officer characteristics were included in analysis: job assignment, tenure in DPD, age, race/ethnicity, sex, college education, military service and deployment history, total number of allegations filed with internal affairs, and number of allegations sustained. Job assignment was coded in three categories: administrative/other (0), patrol (1), and special operations, warrant-serving, or tactical unit

(2). Officer tenure at DPD and age were both originally reported in years; however, due to substantial right skew for both variables, they were recoded as dichotomous categorical variables cut at the median (age: 0 = ≤38 years, 1= >38 years; tenure: 0 = ≤10 years, 1 = >10 years), similar to the approach employed by Gonzalez et al. (2018).[32]

Officer race/ethnicity was initially coded as White, Hispanic, Black, Asian, or Native American/American Indian; however, due to small sample size (n<10) of some groups, this variable was coded for analysis as 0=White, 1=Hispanic/Latina/o, 2=Black, and 3=Asian, Native American/American Indian, or Other. Sex was originally coded as "Male" and "Female" and was assigned numeric categories for analysis (0=female, 1=male). College education was recoded from number of college hours to a dichotomized measure of any college education (0=No college, 1=Any college). Military service history and deployment information obtained from DD Form 214s were originally provided as branch (officers with no military history were coded as "no" in this field while those with military services were coded with the appropriate service branch, e.g. "U.S. Air Force") and deployment status (coded as "yes" or "no" for officers with prior military service, and missing for those without). Both were recoded as dichotomous numeric variables for analysis: 0=no military service and 1=prior military service; and 0=no deployment exposure (including non-military as well as those with military service who were never deployed) and 1=any deployment exposure. Finally, total allegations and sustained allegations with internal affairs by officer were both recoded as categorical variables due to substantial right skew (0 allegations=2, 1 to median number of allegations=1, more than median number=2).

Civilian ("Subject") Characteristics. DPD incident files include data on race/ethnicity and sex for the primary person to whom police were responding in each incident ("subject"); both variables will be included in analysis. For race/ethnicity, original categories included "White", "Hispanic," "Black", "Asian", and "other"; for the current analyses, race/ethnicity was recoded in the same manner as officer race/ethnicity, where 0=White, 1=Hispanic, 2=Black, 3=Asian or Other. Sex ("Male" or "Female" in the original dataset) was similarly assigned numeric categorical values.

Situational Characteristics. Finally, the following situational characteristics were reported for each incident and included in analysis: whether the shooting occurred on or off duty (0=on duty, 1=off duty), whether a weapon was present (coded as 0=no weapon/ unarmed, 1=firearm, 2=other weapon), and time of day (coded as 0=12-5:59am or midnight/early morning, 1=6-11:59am or morning, 2=12-5:59pm or afternoon, and 3=6-11:59pm or evening).

Data Analysis

All analyses were conducted in Stata/IC 15.1. Initial examination of the data revealed the presence of some non-independence due to clustering (a) of multiple officers within a single incident, and (b) of a single officer being involved in multiple incidents over the 10-year time period. Therefore, descriptive results were generated at both the officer level (full 281 cases), and at the incident level (177 unique incidents). Note that although there were a small number of officers involved in two incidents during the 10-year time period, all 281 cases were retained in the officer-level descriptive table, since officers may have had changes in characteristics (e.g. age, tenure, job role) across the two incidents. Since all variables were categorical, proportions are presented in Table 1, including the prevalence of each outcome measure.

To assess factors associated with injury outcomes, unadjusted logistic regression models were first employed for all 281 cases to examine the bivariate association between each independent variable and each outcome. Results are presented separately for civilian (Table 2) and officer (Table 3) injury or fatality, with unadjusted odds ratios, 95% confidence intervals, and p-values reported for each association.

Results of these unadjusted logistic regression analyses were then used to construct separate multivariable logistic regression models for each outcome, with variables eligible for inclusion if the variable's unadjusted p-value met the prespecified significance threshold of $p<0.25$.[51,52] Preliminary fixed-effects logistic regression models, ignoring clustering of the data, were constructed by including all variables that met the minimum significance threshold, except in cases of high collinearity. In cases where two highly correlated variables both met inclusion criteria (including age and tenure with Spearman correlation coefficient=0.79, and total and sustained allegations with Spearman correlation coefficient=0.67), the variable with a lower bivariate p-value was included while the other was dropped. Variance inflation factors were less than 2 for all remaining variables with respect to civilian injury, and less than 4 with respect to officer injury, indicating that multi-collinearity was not a major issue.[53]

To account for clustering, a mixed-effects model was initially attempted with random effect terms for clustering of multiple officers within a single incident (operationalized using a unique incident case identification number) and for repeat incidents for a single officer (operationalized using officer badge number). However, due to the small sample size there were repeated model convergence issues with this approach. To assess the degree to which clustering was associated with the outcome, each random effect term was independently tested with respect to each outcome variable; these preliminary analyses indicated that incident-level clustering (multiple officers within a single incident) was significantly related to the outcomes, but officer-level clustering (multiple incidents for one officer) was not. Based on this finding, generalized estimating equation (GEE) models were fit for each outcome, using an exchangeable correlation structure based on incident-level clustering. While GEE models do not allow prediction as regression models do, this was deemed to be a reasonable alternative analytic approach since the goals of this study are primarily descriptive.[54] Results of the GEE analysis are presented separately for each outcome in Tables 4 and 5, with adjusted odds ratios, 95% confidence intervals, and p-values reported for each included variable.

After fitting an initial GEE model for each outcome (see Appendix A for the full initial GEE models), variables were dropped one at a time using backward selection if their p-value when controlling for covariates exceeded the same threshold of 0.25. Additionally, although civilian sex met inclusion criteria for civilian injury, this variable was not included in multivariable analysis due to the extremely small number of women, resulting in extremely wide confidence intervals and unstable results. Note that while oftentimes researchers use a smaller p-value threshold for retaining variables (e.g., .10, .15),[51] due to the exploratory nature of this study, a more generous p-value was used to explore risk factors that appear to trend towards significance given increased power, while reducing variables with the least contribution to the model to reduce instability.[55]

Missing Data Procedures

To address potential problems due to missing data, all variables included in analysis were first examined for missingness, with the *a priori* criteria that if less than 5% (14) of observations contained missing data,[56] then complete case analysis would be used. This initial examination revealed that missing data was not a major problem, with a maximum of four missing cases for any one variable. Therefore, all analyses used complete case analysis and excluded any cases with missing data.

Post-Hoc Power Analysis

Data for this study were previously collected and it was therefore not feasible to conduct a power analysis *a priori* to identify appropriate sample size. However, post hoc power analysis was used to obtain an assessment of the power of this study to detect the observed effect sizes in unadjusted logistic regression models, and to suggest the sample size that may be necessary for future research. Power analysis was conducted using the G*Power 3 (2007)[57] software program. Power estimations were based on an alpha level of .05; sample size of 281 (assuming no clustering); and underlying probabilities of each outcome under the null hypothesis (equivalent to the probability of each outcome for the referent group), for (a) the smallest observed effect sizes that reached statistical significance, and (b) the smallest observed effect size overall in unadjusted logistic regression models for each outcome. Results of this power analysis are presented on pages 32-33

Human Subjects Considerations

Approval for data collection and the original case-control study was obtained from the Committee for the Protection of Human Subjects (CPHS) at the University of Texas Health Sciences Center in Houston on December 21, 2015 and the author of the present study (Ellen Paddock) was approved as an additional member of the original research team on February 12, 2018. A new IRB protocol was also submitted for the present study, and was approved as exempt by CPHS on August 14, 2018.

RESULTS

Descriptive Results

Descriptive results are presented in Table 1. To compute incident-level descriptive statistics for individual officers, one officer was randomly selected for each incident involving multiple officers. Among the 281 shooting officers, there were 177 unique shooting incidents involving anywhere from one (123 incidents) to 13 (1 incident) shooting officers. Twenty-three (23) officers were involved in two OIS incidents over the 10-year time period; no officer was involved in more than two incidents.

Prevalence of Injury

Civilian injury occurred in a majority of unique OIS incidents, with 61.02% of incidents resulting in any injury or fatality, including more than a third (35.03%) resulting in fatality. Officer injury or fatality occurred in 13.56% of unique incidents, including fatality in 5 (2.82%).

Officer, Civilian, and Situational Characteristics

A large majority of officers who discharged their firearm during a shooting incident were male (96.09%), college-educated (82.21%), and in a patrol role at the time of the shooting (83.99%). A majority of officers were white (56.23%), while 22.42% were Hispanic/Latino/a[i] and 17.08% were black. Within the "other" category, 8 officers were Asian and 4 were Native American or American Indian. The median age of officers at the time of the incident was 38 years, and the median tenure at Dallas Police Department was 10 years. Nearly 30% of all officers had previously served in the military; of these, approximately half were deployed at some point during their service. More than three quarters of shooting officers had at least one allegation filed with Internal Affairs during their time at DPD (range: 0-41 allegations), and 40.93% had one or more allegations sustained (range: 0-20 allegations). The median number of allegations filed was 4 and allegations sustained was 0.

Table 1: Descriptive Characteristics of Officer-Involved Shooting Incidents Recorded by Dallas Police Department, 2005-2015 (n=281)

Sample Characteristics (n=281)	Frequency (n)	Proportion (%)
Officer Characteristics		
Sex, %		
Male	270	96.09%
Female	11	3.91%
Age in Years, %		
≤38 (median age)	149	53.21%
>38	131	46.79%
Race or Ethnicity, %		
White	158	56.23%
Hispanic/Latina or Latino	63	22.42%
Black	48	17.08%
Other race or ethnicity	12	4.27%
Any College Education, %		
Yes	231	82.21%

[i] Race and Hispanic/Latino/a ethnicity were not distinguished in the original coding. All categories used are based on those in the original dataset.

No	50	17.79%
Job Assignment, %		
Administrative	14	4.98%
Patrol	236	83.99%
Special Operations/Tactical Unit	45	11.03%
Tenure at DPD in Years, %		
≤10 (median tenure)	138	49.46%
>10	141	50.54%
Prior Military Service, %		
Yes	82	29.18%
No	199	70.82%
Prior Deployment(s), %		
Yes	40	14.29%
No	240	85.71%
Total Allegations Filed with Internal Affairs (IA)		
0 allegations		
1-4 allegations (at or below median)	61	21.71%
5 or more allegations (above median)	93	33.10%
	127	45.20%
Sustained Allegations with IA, %		
0 allegations (median)	166	59.07%
1 or more allegations sustained (above median)	115	40.93%
Civilian ("Subject") Characteristics		
Sex, %		
Male	272	98.19%
Female	5	1.81%
Race or Ethnicity, %		
White	59	21.30%
Hispanic/Latina or Latino	78	28.16%
Black	136	49.10%
Other race or ethnicity	4	1.44%
Situational Characteristics		
Off Duty, %		
Yes	30	10.68%
No	251	89.32%
Time of Day, %		
12-5:59am (Midnight/Early AM)	60	21.51%
6-11:59am (Morning)	38	13.62%
12-5:59pm (Afternoon)	71	25.45%
6-11:59pm (Evening)	110	39.43%
Weapon Present, %		
No weapon/unarmed	43	15.36%
Firearm	171	61.07%
Other weapon	66	23.57%
Injury Outcomes		
Any Civilian Injury or Fatality (%)	197	70.11%
Any Civilian Fatality (%)	114	40.57%
Any Officer Injury or Fatality (%)	51	18.15%
Any Officer Fatality (%)	11	3.91%

Across the 177 unique incidents (results not shown), a large majority of civilians were male (97.11%), while only 5 (2.89%) were female. In contrast to officers, less than 20% of civilians involved in OIS shootings were observed to be white (19.08%), while nearly half were black, just under a third as Hispanic or Latino/a, and 1.44% as another race or ethnicity (including 1 reported as "Asian" and 3 as "other").[ii]

A majority of shootings occurred while officers were on duty, while 28 unique incidents occurred off-duty during the 10-year time period. In just under one-quarter of these incidents the civilian had no weapon or was unarmed, while just over a quarter of incidents involved a (non-law enforcement) firearm. The remaining half of incidents was coded as having "other weapons", a broad category which included objects commonly used as a weapon (e.g. knife, OC spray, TASER) as well as other objects such as a vehicle, screwdriver, toy gun or BB gun. Lastly, more than half of the OIS incidents occurred at night (6pm-6am), with the greatest proportion of incidents occurring from 6-11:59pm and the lowest proportion occurring from 6-11:59am.

Bivariate (Unadjusted) Logistic Regression Results

Civilian Injury or Fatality

Table 2 presents the results of separate unadjusted logistic regression models for the relationship between each situation factor with civilian injury. In these unadjusted models, the factors significantly associated with civilian injury were officer race/ethnicity, job assignment, civilian sex, civilian race/ethnicity, off duty status, and time of day.

[ii] For civilians, race/ethnicity is based on driver's license or ID if available, or officer observation if not available (e.g., person left after the shooting). See discussion section, page 38.

Compared to white officers, black officers had 63% lower odds (OR=.37, 95% CI .18-.73, p=.004) and Hispanic/Latino officers had 56% lower odds (OR=.44, 95% CI .23-.83, p=.012) of civilian injury. The odds of civilian injury did not vary for officers of another race/ethnicity compared to white officers. Officers in special operations or tactical roles also had 14.50 times higher odds of being involved in an incident where civilian injury or fatality occurred compared to administrative officers (95% CI 2.46-85.56, p=.003). There was no statistically significant difference in the odds of civilian injury or fatality in patrol officers versus administrative officers.

Civilian race/ethnicity was also strongly associated with injury or fatality during OIS incidents. When compared to white civilians, Hispanic/Latino and black civilians were 88% (OR=.12, 95% CI: .04-.38, p<.001) and 83% (OR=.17, 95% CI: .06-.49, p=.001) less likely to incur an injury or fatality during OIS incidents, respectively. There was no statistically significant difference noted in injury or fatality during OIS incidents in white civilians versus civilians classified in the other race/ethnicity category. Male sex was also associated with higher unadjusted odds of injury (OR=10.49, 95% CI 1.15-95.36, p=.037) compared to women.

With respect to situational characteristics, off-duty status was associated with lower odds of civilian injury compared to on-duty incidents (OR=.36, 95% CI .17-.77, p=.009). Notably, while more than half of OIS *incidents* occurred at night, unadjusted analyses found that unadjusted odds of injury were higher during the daytime, with the odds of civilian injury 9.84 times higher during incidents that occurred from 6am-11:59am (95% CI 3.08-31.42, p<.001) and 9.39 times higher for incidents that occurred from 12-5:59pm (95% CI

3.81-23.13, p<.001) compared to those between 12-5:59am. Notably, the presence of a firearm or other weapon was not significantly associated with civilian injury.

In addition to these variables, total and sustained allegations, and presence of a weapon met criteria for initial inclusion in multivariable models (i.e., p<.25), while officer sex, age, college education, tenure, military service, and deployment did not.

Table 2: Bivariate Association Between Each Incident Characteristic and Civilian Injury or Fatality, Unadjusted Odds Ratios (OR) with 95% Confidence Interval (CI)

Civilian Injury or Fatality, Unadjusted Odds Ratios (n=281)		
Sample Characteristics	Unadjusted OR (95% CI)	P-value
Officer Characteristics		
Sex		
Female	(ref)	
Male	.92 (.24-3.56)	.904
Age in Years		
≤38 (median age)	(ref)	
>38	.83 (.49-1.40)	.488
Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	**.44 (.23-.83)**	**.012**
Black	**.37 (.18-.73)**	**.004**
Other race or ethnicity	.81 (.21-3.17)	.764
Any College Education		
No	(ref)	
Yes	1.20 (.62-2.32)	.591
Job Assignment		
Administrative	(ref)	
Patrol	2.27 (.77-6.71)	.139
Special Operations/Tactical Unit	**14.50 (2.46-85.56)**	**.003**
Tenure at DPD in Years, %		
≤10 (median tenure)	(ref)	
>10	.86 (.51-1.46)	.581
Prior Military Service		
No	(ref)	
Yes	1.13 (.63-2.01)	.685
Prior Deployment(s)		
No	(ref)	
Yes	1.27 (.59-2.73)	.549
Total Allegations Filed with Internal Affairs		
0	(ref)	
1-4 (at or below median)	.61 (.29-1.31)	.206
5 or more (above median)	.65 (.32-1.35)	.251

Sustained Allegations with Internal Affairs		
0 (median)	(ref)	
1 or more (above median)	.60 (.36-1.02)	.058
Civilian ("Subject") Characteristics		
Sex		
Female	(ref)	
Male	**10.49 (1.15-95.36)**	**.037**
Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	**.12 (.04-.38)**	**.000**
Black	**.17 (.06-.49)**	**.001**
Other race or ethnicity	[empty][iii]	
Situational Characteristics		
Off Duty		
No	(ref)	
Yes	**.36 (.17-.77)**	**.009**
Time of Day		
12-5:59am	(ref)	
6-11:59am	**9.84 (3.08-31.42)**	**.000**
12-5:59pm	**9.39 (3.81-23.13)**	**.000**
6-11:59pm	**2.55 (1.32-4.93)**	**.005**
Weapon Present		
No weapon/unarmed	(ref)	
Firearm	1.95 (.94-4.04)	.072
Other weapon	.73 (.33-1.61)	.432

Officer Injury or Fatality

Results of unadjusted regression models for each situational characteristic and officer injury or fatality are presented in Table 3. In these unadjusted models, the factors significantly associated with officer injury were age and tenure (which, as previously described, are highly correlated), job assignment, officer race/ethnicity, and the presence of a non-law enforcement firearm.

Above-median age and above-median tenure had a similar magnitude of association, though age provided a slightly more precise association as measured by the 95% confidence interval: officers aged 38 years or more had 2.45 times higher odds of officer injury

[iii] Group too small/no difference in outcomes

occurring during an OIS incident compared to younger officers (95% CI 1.30-4.61, p=.005). When compared to officers with tenure less than 10 years, those with tenure over 10 years had 2.52 times higher odds of injury occurring (95% CI: 1.32-4.80, p=.005). It should be noted that while age was dichotomized for analysis due to the small sample size, post hoc analyses investigating the bivariate association between officer injury and 10-year age categories suggest a dose-response relation of the odds of injury with increasing age categories, though only the association for officers over 50 was statistically significant [i.e., compared to officers aged 20-29 years, officers ages 30-39 years had 3.49 times higher odds (95% CI .44-27.47, p=.236), officers aged 40-49 years had 6.97 times higher odds (95% CI .88-55.11, p=.066), and officers aged 50 years and older had 13.85 times higher odds (95% CI 1.70-112.95, p=.014) of injury during OIS incidents].

With respect to job assignment, officers in an administrative role appeared to have the highest odds of injury when involved in an OIS incident, while being a patrol officer had a protective association. Compared to administrative officers, patrol officers had 92% lower odds of injury occurrence during an OIS incidence (OR=.08, 95% CI: .02-.25, p<.001), while there was no statistically significant difference in the odds of officer injury during OIS events involving tactical officers versus administrative officers.

Officer race was significantly associated with injury only when comparing black and white officers, as incidents when the officer was black had 2.42 times higher odds of officer injury compared to white officers (95% CI 1.13-5.19, p=.023); all other comparisons were statistically null. Similarly, while the presence of a non-law enforcement firearm significantly increased the odds of officer injury compared to no weapon/unarmed (unadjusted OR=6.89, 95% CI 1.60-29.68, p=.01), the presence of other weapons was not significantly associated.

Prior deployments, total allegations with internal affairs, and time of day, though not significant at a significance level of 0.05, met the minimum criteria for inclusion in initial multivariable models (p<.25). Officer sex, college education, military service, and sustained allegations were all highly nonsignificant with p-values of .25 or higher.

Table 3: Bivariate Association Between Each Incident Characteristic and Officer Injury or Fatality, Unadjusted Odds Ratios (OR) with 95% Confidence Interval (CI)

Officer Injury or Fatality, Unadjusted Odds Ratios (n=281)		
Sample Characteristics	Unadjusted OR (95% CI)	P-value
Officer Characteristics		
Sex		
Female	(ref)	
Male	2.27 (.28-18.16)	.439
Age in Years		
≤38 (median age)	(ref)	
>38	**2.45 (1.30-4.61)**	**.005**
Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	1.68 (.80-3.52)	.171
Black	**2.42 (1.13-5.19)**	**.023**
Other race or ethnicity	[empty]	
Any College Education		
Yes	(ref)	
No	1.45 (.61-3.43)	.403
Job Assignment		
Administrative	(ref)	
Patrol	**.08 (.02-.25)**	**.000**
Special Operations/Tactical	.40 (.11-1.49)	.170
Tenure at DPD in Years, %		
≤10 (median tenure)	(ref)	
>10	**2.52 (1.32-4.80)**	**.005**
Prior Military Service		
No	(ref)	
Yes	1.41 (.74-2.69)	.290
Prior Deployment(s)		
No	(ref)	
Yes	.46 (.15-1.34)	.155
Total Allegations Filed with Internal Affairs		
0	(ref)	
1-4 (at or below median)	2.39 (.95-6.01)	.064
5 or more (above median)	1.62 (.65-4.02)	.302

Sustained Allegations with Internal Affairs		
0 (median)	(ref)	
1 or more (above median)	1.01 (.55-1.88)	.968
Civilian ("Subject") Characteristics		
Sex		
Female	(ref)	-
Male	[empty]	
Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	1.22 (.49-3.04)	.676
Black	1.44 (.63-3.28)	.385
Other race or ethnicity	[empty]	-
Situational Characteristics		
Off Duty		
No	(ref)	
Yes	1.43 (.58-3.54)	.438
Time of Day		
12-5:59am	(ref)	
6-11:59am	2.02 (.74-5.57)	.172
12-5:59pm	1.78 (.73-4.36)	.204
6-11:59pm	.89 (.37-2.19)	.807
Weapon Present		
No weapon/unarmed	(ref)	
Firearm	**6.89 (1.60-29.68)**	**.010**
Other weapon	2.05 (.39-10.66)	.393

Generalized Estimating Equation (GEE) Multivariable Results

Based on the model inclusion criteria (see Data Analysis, page 17), the initial multivariable GEE model for civilian injury or fatality included officer race/ethnicity, job assignment, sustained allegations (total allegations met inclusion criteria but was excluded due to correlation with sustained), civilian race/ethnicity, off duty status, time of day, and weapon. The initial model for officer injury or fatality included officer race/ethnicity, officer age (tenure excluded due to high correlation with age), job assignment, deployment, total allegations, time of day, and weapon. Results of these initial full GEE models are presented in Appendix A. After fitting the initial GEE models, backwards selection was used to remove variables one by one that no longer met the threshold for model retention.

The final reduced model for civilian injury or fatality is shown in Table 4 and includes officer race/ethnicity, job assignment, civilian race/ethnicity, time of day, and whether a weapon was present. The final model for officer or fatality, shown in Table 5, includes officer race/ethnicity, job assignment, and whether a weapon was present.

Civilian Injury or Fatality GEE Results

In the final GEE model controlling for clustering at the incident level and other covariates included in the model (Table 4), only civilian race/ethnicity and time of day retained a statistically significant association with civilian injury or fatality during OIS incidents. Compared to white civilians, Hispanic or Latina/o civilians had 79% times lower adjusted odds of injury (AOR=.21, 95% CI .06-.72, p=.013) and black civilians had 78% lower adjusted odds of injury (AOR=.22, 95% CI .07-.72, p=.012).[iv] Time of day was also statistically significant, with the highest odds of civilian injury in the afternoon (12-5:59pm: AOR=5.46, 95% CI 1.90-15.73), and the lowest odds from midnight to 6am. Officer race/ethnicity, job assignment, and presence of a weapon did not retain a significant association with civilian injury in the final model.

Table 4: Reduced Generalized Estimating Equation (GEE) Model Predicting Civilian Injury and/or Fatality for Officer-Level Data, Adjusted Odds Ratios with 95% Confidence Interval (CI)

Civilian Injury or Fatality, GEE Adjusted Odds Ratios		
Sample Characteristics (n=267)	Adjusted OR (95% CI)	P-value
Officer Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	.60 (.31-1.17)	.135
Black	.54 (.26-1.13)	.103
Other race or ethnicity	.61 (.13-2.77)	.523

[iv] The Other race/ethnicity category was dropped from the model due to small sample size and because there was no difference in outcomes within this group—no injuries occurred during incidents involving civilians reported as "Other race/ethnicity."

Job Assignment		
Administrative	(ref)	
Patrol	1.93 (.42-8.99)	.400
Special Operations/Tactical	7.58 (.72-80.01)	.092
Civilian Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	**.21 (.06-.72)**	**.013**
Black	**.22 (.07-.72)**	**.012**
Other race or ethnicity	[empty]	
Time of Day		
12-5:59am	(ref)	
6-11:59am	**4.78 (1.36-16.75)**	**.015**
12-5:59pm	**5.46 (1.90-15.73)**	**.002**
6-11:59pm	**2.69 (1.17-6.18)**	**.020**
Weapon Present		
No weapon/unarmed	(ref)	
Firearm	1.00 (.41-2.43)	.995
Other weapon	.45 (.17-1.20)	.112
Overall Wald Chi-Square (P-value)		31.30 (.0018)

**Initial model fit with all variables that reached the a priori threshold of p<.25, and retained in the model if they remained significant at p<.25 in the adjusted model. Total officer-level dataset includes 281 shooting officers; 14 cases were dropped from analysis due to missing data and/or few cases with no difference in outcomes (civilian other race or ethnicity—4 cases; all of these were non-injury cases.)*

Officer Injury or Fatality GEE Results

In the final GEE model, only officer job assignment remained significantly associated with officer injury, with patrol officers having 81% lower odds of injury when involved in an OIS incident compared to administrative officers (AOR=.19, 95% CI .04-.89, p=.036). Presence of a firearm approached, but did not reach, statistical significance (AOR=3.71, 95% CI .83-16.56, p=.086). All other associations appeared nonsignificant in the final model.

Table 5: Reduced Generalized Estimating Equation (GEE) Model Predicting Officer Injury and/or Fatality for Officer-Level Data, Adjusted Odds Ratios with 95% Confidence Interval (CI)

Officer Injury or Fatality, GEE Adjusted Odds Ratios		
Sample Characteristics (n=265)	Adjusted OR (95% CI)	P-value
Officer Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	1.13 (.61-2.09)	.704
Black	1.63 (.82-3.20)	.160
Other race or ethnicity	[empty]	

Job Assignment		
Administrative	(ref)	
Patrol	**.19 (.04-.89)**	**.036**
Special Operations/Tactical	.49 (.08-3.15)	.456
Weapon Present		
No weapon/unarmed	(ref)	
Firearm	3.71 (.83-16.56)	.086
Other weapon	1.70 (.32-9.03)	.532
Overall Wald Chi-Square (P-value)		14.19 (.0276)

**Initial model fit with all variables that reached the a priori threshold of p<.25, and retained in the model if they remained significant at p<.25 in the adjusted model. Total officer-level dataset includes 281 shooting officers; 14 cases were dropped from analysis due to missing data and/or few cases with no difference in outcomes (civilian other race or ethnicity—4 cases; all of these were non-injury cases.)*

Post-Hoc Power Analysis Results

Post-hoc power analyses were conducted for unadjusted logistic regression results, using an alpha of .05, sample size of 281, and (a) the smallest observed effect sizes that reached statistical significance and (b) the smallest observed effect size overall for each outcome. For civilian injury, the smallest effect size that reached statistical significance was the association between officer race—Hispanic/Latino compared to white (OR=.44), and the smallest overall was for officer sex (OR=.92); for officer injury, the smallest effect size that reached statistical significance was for officer race—black compared to white (OR=2.42), and the smallest overall was for sustained allegations above the median (OR=1.01).

Results of the power analysis conducted in G*Power 3 (2007)[57] are shown in Table 6. For officer race/ethnicity, which had the smallest effect size to reach statistical significance for both civilian and officer injury, statistical power for both outcomes was computed as greater than 99% given the underlying probability of injury for the referent group (white officers) in each case. For officer sex and civilian injury, the statistical power to detect the observed odds ratio of .92 was 15%. For sustained allegation and officer injury, the power to detect the observed odds ratio of 1.01 was 6%.

Table 6: Power to Detect Observed Effect Sizes in Unadjusted Logistic Regression Models, Assuming No Clustering, α=.05, n=281

Sample Characteristic	Observed Unadjusted OR	Computed Power
Officer Race/Ethnicity (Hispanic/Latino vs. White) and Civilian Injury	.44	>.99
Officer Sex and Civilian Injury	.92	.15
Officer Race/Ethnicity (Black vs White) and Officer Injury	2.42	>.99
Sustained Allegations Above the Median and Officer Injury	1.01	.06

DISCUSSION

Findings from this exploratory study suggest that injuries to civilians, and to a lesser extent officers, were highly prevalent during officer-involved shooting incidents reported by Dallas Police Department from 2005-2015. With respect to risk factors for injury, study results suggest five key findings. First, black and Hispanic civilians comprised the highest number of civilian injury or fatalities, but odds of injury were highest for incidents involving white civilians when adjusting for clustering and covariates included in the model. Second, time of day remained significantly associated with civilian but not officer injury, with odds of civilian injury highest during the daytime. Third, job assignment was the only risk factor that retained a statistically significant association with officer injury in adjusted models, with administrative officers at substantially higher odds of officer injury compared to patrol officers when involved in an OIS incident. Fourth, although age (dichotomized at the median) was dropped from the model because of non-significance, bivariate analyses of 10-year age categories suggested a possible dose-response association between increasing age category and odds of injury. Fifth, several notable variables, including presence of a weapon, were *not* significantly associated with either civilian or officer injury during officer-involved shootings. These findings are discussed in greater detail below.

The first key finding was that civilian race/ethnicity was significantly associated with civilian injury outcomes. Descriptive results indicated that in more than three-quarters of unique OIS incidents, the primary person being confronted by Dallas police officers was either black (49%) or Hispanic/Latinx (30%), while whites comprised less than 20% of those involved. Similar to patterns observed across the US,[33] this demographic distribution differed substantially from the larger Dallas population, which according to census estimates is 61% white alone, 41.5% Hispanic/Latinx, and 24.6% black alone,[58] suggesting that black residents of Dallas in particular are disproportionally involved in OIS incidents. However, when it comes to *injury* during the course of OIS incidents, these results indicated that the minority of incidents involving white civilians also had the highest odds of civilian injury or fatality, even when controlling for other factors. Post-analysis examination of civilian injury or fatality by race showed that of the 32 unique events involving white civilians between 2005-2015 with valid outcome data,[v] 29 (90.6%) resulted in civilian injury, compared to 25 (51.0%) of the 52 incidents involving a Hispanic/Latino/a civilian, 52 (61.2%) of the 85 events involving black civilians, and none of the 3 events involving civilians with another identified race/ethnicity. With respect to fatality, 20 (62.5%) incidents involving white

[v] There was 1 missing civilian injury outcome involving a white civilian, and 3 missing outcomes involving a Hispanic/Latino/a outcome. No outcome data was missing for black civilians or other race/ethnicity.

civilians, 13 (26.5%) involving Hispanic/Latino/a civilians, and 27 (31.8%) involving black civilians resulted in fatality.

Limited information is available in the broader literature that might explain this finding, since previous research has tended to focus on fatal shootings and/or only injurious shootings without including non-injury shootings, and one of the few such studies to include firearm discharges more broadly did not include civilian race as a possible predictor.[25] It is possible that situational or intangible factors may explain the difference in injury odds for different racial/ethnic groups, but aside from controlling for the race and job assignment of the responding officer and presence of a weapon, few such factors were available in the current data. It is also possible that because black and Hispanic/Latino/a people are involved in a higher proportion of OIS incidents—and even stopped for lower level offenses such as traffic violations at a higher rate[59]— the times when white people *are* involved in shootings may represent more extreme circumstances. However, without additional data this is purely speculative. One difference which can largely be ruled out is intent, since all but three cases in this study were reported as intentional shootings. In general, additional research is needed to make sense of this finding, and the associations observed in this study should serve primarily to generate directions for thus future research.

The second key finding was that civilian injury was significantly associated with time of day, with the greatest odds of injury during the daytime. Previous research on the relationship between civilian injury or fatality and time of day has primarily been conducted in the context of "accuracy" or "hit rates,"[25,60-62] which as mentioned in the introduction to this paper is synonymous with at least minor injury when it comes to discharging a firearm.

Results of this study showed that a majority of incidents occurred at night (between 6pm and 6am), but that the odds of injury were highest during OIS incidents that occurred during the daytime. This finding is consistent with previous studies, several of which have identified differences in lighting as a primary underlying mechanism affecting the frequency with which law enforcement hit the people they are shooting at.[61,62]

The third key finding was that officer injury was significantly associated with job assignment in adjusted models, with patrol officers having lower odds of injury compared to administrative officers when involved in OIS incidents. Notably, the number of administer officers was small (n=14), and so this finding should be interpreted with caution. However, there is theoretical plausibility to this association given that administrative officers may be less routinely involved in direct encounters with civilians,[63] and therefore possibly more vulnerable to injury when they do so. The fact that tactical officers had no significant difference in odds of injury compared to administrative officers may obscure what is actually an increased risk of injury compared to regular patrol officers, due to the nature of situations that tactical officers routinely engage in and/or other differences in roles.[64,65] This theory was supported by post hoc analyses comparing patrol and tactical officers,[vi] which found that tactical officers had more than five times higher unadjusted odds of injury when compared to patrol officers alone ($p<.001$).

The fourth key finding was that officer age, though not significantly associated with officer injury when dichotomized, demonstrated trends suggestive of a possible increasing dose-response association when analyzed in 10-year increments. Although age cut at the

[vi] Excluding administrative officers

median was dropped from multivariable models and thus nonsignificant when adjusting for other covariates, this non-association may in part be an artefact of the decision to treat age as a dichotomous variable due to the small number of officer injury cases. This assertion is justified by post-hoc bivariate analyses examining officer age in 10-year categories compared to the youngest age category (20-29 years), which indicate that the odds of officer injury increased with each successive 10-year increase in age, though these results reached significance only for officers over age 50 years. This finding has biologic plausibility given prior research that workers over 55 years of age generally may be at increased risk for some type of occupational injuries,[66] and suggests that future studies should carefully consider how they operationalize age in data analysis.

Finally, several characteristics, including presence of a weapon, were not significantly associated with either civilian or officer injury. OIS incidents are high-tension situations, and justification for the use of deadly force often revolves around real or perceived imminent threat.[15-17] However, findings from this study indicated that the presence of a weapon was not significantly associated with either civilian or officer injury in adjusted models, although the presence of a non-law enforcement firearm more closely approached significance in both cases. In contrast, the presence of another weapon type was highly nonsignificant compared no weapon. The data do not address officer's *perceptions* of whether or not a weapon was present, which may affect their response as much as the actual presence of a weapon.[25,67-69] Nevertheless, the finding that the presence of weapons had no association with injury undermines the idea of imminent threat and reinforces the importance of using alternative methods to deescalate or control a situation wherever possible. With respect to civilian injury specifically, it is also worth noting that officer characteristics broadly were not significantly associated with civilian injury, including factors associated with the probability of OIS involvement in previous research, such as lower officer age and experience.[28-30] Although officer race/ethnicity did not retain significance in the final adjusted models for either civilian or officer injury outcomes, the p-values in both cases approached statistical significance and suggest that a possible effect may be detectable with increased sample size. In the case of this study sample, results suggested that odds of civilian injury were lower in cases where black and Hispanic officers were shooting, while odds of *officer* injury tended higher when the shooting officer was black, though again both results were nonsignificant in adjusted models.

Results of this study should be interpreted cautiously, and treated primarily as a single-site study of shootings in Dallas from 2005-2015 with limited external study validity. Several specific limitations must also be taken into consideration when examining the results. First, the relatively small sample size—while undoubtedly a good thing in real-world terms, since it means fewer shooting incidents—limits the ability to reliably examine a large number of possible risk factors for injury and contributes to imprecise estimates for many of the computed odds ratios, as illustrated by wide confidence intervals. Additionally, combining shootings across a 10-year time period in cross-sectional analysis may obscure secular trends in the frequency or characteristics of OIS incidents during this time period.

Other possible threats to internal and external study validity relate to the way that data were collected. First, while by default civilian race/ethnicity was recorded by officers based on the person's driver's license, in cases where police had no contact with the person after the incident, race/ethnicity was recorded based on officer observation, creating the possibility of misclassification (though it is worth noting that some evidence suggests that observed race/ ethnicity may be more strongly related to disparities in treatment in some circumstances[70]). Second, the lack of data on the nature and/or severity of injury may obscure important differences in outcomes. Lastly and more generally, data were collected by DPD officers, and may be vulnerable to some extent to the same issues of underreporting observed across the country.[3-7]

Despite these limitations, this study makes a unique contribution to the literature in differentiating between injurious and non-injurious shootings, and in seeking to understand the factors associated with actual injury during officer-involved shootings. While the degree to which these risk factors are modifiable and may inform practice varies, some findings do have potential implications for training. For example, the lack of association between non-firearm weapon presence and either civilian or officer injury may be used to help train on alternative response options and reinforce the inutility of shooting for preventing harm during such encounters. However, in general one of the primary strengths of this study is to generate hypotheses for future research regarding injury occurrence during officer-involved shootings.

CONCLUSION

Data on shootings by Dallas police officers between 2005-2015 revealed that injury to civilians occurs in a majority of OIS incidents, and injury to officers in approximately 14% of incidents. Among the potential risk factors for injury included in analysis, civilian race/ethnicity appeared to play an important role in civilian injury: black and Hispanic/Latino/a civilians comprised the highest number of injuries or fatalities, while whites had the highest odds of injury when involved in an OIS incident. Time of day also appeared to be an important factor, with higher odds of injury during the daytime. With respect to officer injury, job assignment appeared to have the strongest association of the risk factors studied, with administrative and tactical officers both having higher odds of injury than patrol. Other situational and officer characteristics, including the presence of a weapon, did not retain a statistically significant association with either officer or civilian injury. These findings should be interpreted cautiously, but suggest novel directions for future research regarding officer-involved shootings, injury, and fatality. In particular, future studies should seek to identify risk factors for injury in other jurisdictions and/or using data pooled across multiple jurisdictions; collect or abstract more detailed and robust information on the nature and severity of injury, and seek to better understand the possible mechanisms underlying associations observed in this study.

APPENDICES

Appendix A. Full GEE Models for Civilian and Officer Injury

The following models contain all variables significant at p<.25 in unadjusted bivariate analyses. Results of these adjusted GEE models were used to develop the final reduced models presented in the Results section.

Appendix Table 1: Full Generalized Estimating Equation (GEE) Model Predicting Civilian Injury or Fatality, Adjusted Odds Ratios with 95% Confidence Interval (CI)

Civilian Injury or Fatality, GEE Adjusted Odds Ratios		
Sample Characteristics (n=267)	Adjusted OR (95% CI)	P-value
Officer Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	.61 (.31-1.22)	.164
Black	.58 (.27-1.26)	.169
Other race or ethnicity	.63 (.14-2.85)	.544
Job Assignment		
Administrative	(ref)	
Patrol	1.87 (.40-8.78)	.429
Special Operations/Tactical	6.96 (.64-75.80)	.111
Officer Sustained Allegations with IA		
0 (median)	(ref)	
1 or more (above median)	.74 (.43-1.27)	.268
Civilian Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	.22 (.06-.75)	.016
Black	.22 (.07-.71)	.012
Other race or ethnicity	[empty]	
Off Duty		
No	(ref)	
Yes	.72 (.26-2.01)	.535
Time of Day		
12-5:59am	(ref)	
6-11:59am	4.75 (1.34-16.83)	.016
12-5:59pm	5.62 (1.92-16.42)	.002
6-11:59pm	2.50 (1.07-5.84)	.036
Weapon Present		
No weapon/unarmed	(ref)	
Firearm	1.00 (.41-2.44)	.993
Other weapon	.45 (.17-1.21)	.113
Overall Wald Chi-Square (P-value)		32.17 (.0038)

**Initial model fit with all variables that reached the a priori threshold of p<.25, and retained in the model if they remained significant at p<.25 in the adjusted model. Total officer-level dataset includes 281 shooting officers; 14 cases were dropped from analysis due to missing data and/or few cases with no difference in outcomes (civilian other race or ethnicity—4 cases; all of these were non-injury cases.)*

Appendix Table 2: Full Generalized Estimating Equation (GEE) Model Predicting Officer Injury or Fatality, Adjusted Odds Ratios with 95% Confidence Interval (CI)

Officer Injury or Fatality, GEE Adjusted Odds Ratios		
Sample Characteristics (n=265)	Adjusted OR (95% CI)	P-value
Officer Race or Ethnicity		
White	(ref)	
Hispanic/Latina or Latino	1.01 (.54-1.88)	.983
Black	1.55 (.79-3.06)	.202
Other race or ethnicity	[empty]	
Age in Years		
≤38 (median age)	(ref)	
>38	1.41 (.78-2.56)	.259
Job Assignment		
Administrative	(ref)	
Patrol	.19 (.04-.99)	.048
Special Operations/Tactical	.51 (.07-3.50)	.495
Prior Military Deployment(s)		
No	.78 (.34-1.76)	.549
Yes		
Total Allegations Filed with IA		
0	(ref)	
1-4 (at or below median)	1.32 (.63-2.77)	.458
5 or more (above median)	.76 (.36-1.62)	.482
Time of Day		
12-5:59am		
6-11:59am		
12-5:59pm		
6-11:59pm		
Weapon Present		
No weapon/unarmed	(ref)	
Firearm	3.79 (.82-17.53)	.088
Other weapon	1.74 (.32-9.52)	.521
Overall Wald Chi-Square (P-value)		19.73 (.1023)

**Initial model fit with all variables that reached the a priori threshold of p<.25, and retained in the model if they remained significant at p<.25 in the adjusted model. Total officer-level dataset includes 281 shooting officers; 14 cases were dropped from analysis due to missing data and/or few cases with no difference in outcomes (civilian other race or ethnicity—4 cases; all of these were non-injury cases.)*

Appendix B. Institutional Approvals Documents

UTHealth
The University of Texas
Health Science Center at Houston

Committee for the Protection of Human Subjects

6410 Fannin Street, Suite 1100
Houston, Texas 77030

Ellen Paddock
UT-H - SPH - Master of Public Health (Epidemiology)

August 14, 2018

HSC-SPH-18-0661 - *Factors Associated with Civilian and Police Officer Injury During 10 Years of Officer-Involved Shooting Incidents: A Cross-Sectional Analysis*

The above named project is determined to qualify for exempt status according to 45 CFR 46.101(b)

CATEGORY #4 *: Research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects.*

CHANGES: Should you choose to make any changes to the protocol that would involve the inclusion of human subjects or identified data from humans, please submit the change via iRIS to the Committee for the Protection of Human Subjects for review.

INFORMED CONSENT DETERMINATION:
Waiver of Consent Granted

HEALTH INSURANCE PORTABILITY and ACCOUNTABILITY ACT (HIPAA):
Exempt from HIPAA

STUDY CLOSURES: Upon completion of your project, submission of a study closure report is required. The study closure report should be submitted once all data has been collected and analyzed.

Should you have any questions, please contact the Office of Research Support Committees at 713-500-7943.

UTHealth
The University of Texas
Health Science Center at Houston

Committee for the Protection of Human Subjects
6410 Fannin Street, Suite 1100
Houston, Texas 77030

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NOTICE OF APPROVAL TO IMPLEMENT REQUESTED CHANGES

HSC-SPH-15-0957 - A Case-Control Study to Reduce Police Officer-Involved Shootings
PI: Dr. Jennifer Gonzalez

Reference Number: 165998

PROVISIONS: Unless otherwise noted, this approval relates to the research to be conducted under the above referenced title and/or to any associated materials considered at this meeting, e.g. study documents, informed consent, etc.

APPROVED: By Expedited Review and Approval

CHANGE APPROVED: Addition of Ellen Paddock to study team

APPROVAL DATE: 02/12/2018

CHAIRPERSON: Rebecca Lunstroth, JD

Upon receipt of this letter, and subject to any provisions noted above, you may now implement the changes approved at this meeting.

CHANGES: The principal investigator (PI) must receive approval from the CPHS before initiating any changes, including those required by the sponsor, which would affect human subjects, e.g. changes in methods or procedures, numbers or kinds of human subjects, or revisions to the informed consent document or procedures. The addition of co-investigators must also receive approval from the CPHS. ALL PROTOCOL REVISIONS MUST BE SUBMITTED TO THE SPONSOR OF THE RESEARCH.

INFORMED CONSENT: Informed consent must be obtained by the PI or designee(s), using the format and procedures approved by the CPHS. The PI is responsible to instruct the designee in the methods approved by the CPHS for the consent process. The individual obtaining informed consent must also sign the consent document. **Please note that if revisions to the informed consent form were made and approved, then old blank copies of the ICF MUST be destroyed. Only copies of the appropriately dated, stamped approved informed consent form can be used when obtaining consent.**

UNANTICIPATED RISK OR HARM, OR ADVERSE DRUG REACTIONS: The PI will immediately inform the CPHS of any unanticipated problems involving risks to subjects or others, of any serious harm to subjects, and of any adverse drug reactions.

RECORDS: The PI will maintain adequate records, including signed consent documents if required, in a manner that ensures subject confidentiality.

REFERENCES

1. Smith MR, Kaminski RJ, Alpert GP, Fridell LA, MacDonald J, Kubu B. A multi-method evaluation of police use of force outcomes: Final report to the National Institute of Justice. *Survey Methodology.* 2009;3:1.

2. Klinger D, Rosenfeld R, Isom D, Deckard M. Race, crime, and the micro-ecology of deadly force. *Criminology & Public Policy.* 2016;15(1):193-222.

3. Alpert GP. Toward a national database of officer-involved shootings: A long and winding road. *Criminology & Public Policy.* 2016;15(1):237-242.

4. Feldman JM, Gruskin S, Coull BA, Krieger N. Quantifying underreporting of law-enforcement-related deaths in United States vital statistics and news-media-based data sources: A capture–recapture analysis. *PLoS Medicine.* 2017;14(10):e1002399.

5. Krieger N, Chen JT, Waterman PD, Kiang MV, Feldman J. Police killings and police deaths are public health data and can be counted. *PLoS medicine.* 2015;12(12): e1001915.

6. Klinger DA, Slocum LA. Critical assessment of an analysis of a journalistic compendium of citizens killed by police gunfire. *Criminology & Public Policy.* 2017;16(1):349-362.

7. Richardson JB, Vil CS, Cooper C. Who shot ya? How emergency departments can collect reliable police shooting data. *Journal of Urban Health.* 2016;93(1):8-31.

8. Ozkan T, Worrall JL, Zettler H. Validating media-driven and crowdsourced police shooting data: a research note. *Journal of Crime and Justice.* 2017:1-12.

9. Wheeler AP, Phillips SW, Worrall JL, Bishopp SA. What Factors Influence an Officer's Decision to Shoot? The Promise and Limitations of Using Public Data. *Justice Research and Policy.* 2017;18(1):48-76.

10. Williams HE, Bowman SW, Jung JT. The limitations of government databases for analyzing fatal officer-involved shootings in the United States. *Criminal Justice Policy Review.* 2016:1-22.

11. Barber C, Azrael D, Cohen A, et al. Homicides by police: comparing counts from the national violent death reporting system, vital statistics, and supplementary homicide reports. *American Journal of Public Health.* 2016;106(5):922-927.

12. Federal Bureau of Investigation (FBI). Expanded Homicide, 2016. https://ucr.fbi.gov/crime-in-the-u.s/2016/crime-in-the-u.s.-2016/topic-pages/expanded-homicide. Published 2017. Accessed March 4, 2018.

13. Mapping Police Violence. About the Data. *Mapping Police Violence*. https://mappingpoliceviolence.org/aboutthedata/. Published 2017. Accessed March 4, 2018.

14. Miller TR, Lawrence BA, Carlson NN, et al. Perils of police action: a cautionary tale from US data sets. *Injury Prevention.* 2016:23;27-32.

15. International Association of Chiefs of Police (IACP). *National Consensus Policy and Discussion Paper on Use of Force.* International Association of Chiefs of Police;2017.

16. Article 3,UN Code of Conduct for Law Enforcement Officials, G.A. res. 34/169, annex, 34 U.N. GAOR Supp. (No. 46) at 186, U.N. Doc. A/34/46 (1979); Principle 9, Basic Principles on the Use of Force and Firearms by Law Enforcement Officials, Eighth United Nations Congress on the Prevention of Crime and the Treatment of Offenders, Havana, 27 August to 7 September 1990, U.N. Doc. A/CONF.144/28/Rev.1 at 112 (1990).

17. Amnesty International. Deadly force: Police use of lethal force in the United States. 2015. https://www.amnestyusa.org/files/aiusa_deadlyforcereportjune2015.pdf. Accessed March 4, 2018.

18. Bozeman WP, Stopyra JP, Klinger DA, et al. Injuries associated with police use of force. *Journal of Trauma and Acute Care Surgery.* 2018;84(3):466-472.

19. Ferdik FV, Kaminski RJ, Cooney MD, Sevigny EL. The influence of agency policies on conducted energy device use and police use of lethal force. *Police Quarterly.* 2014;17(4):328-358.

20. Alpert GP, Dunham RG. *An Analysis of Police Use-of-force Data.* National Institute of Justice; 1998.

21. New York City Police Department (NYPD). NYPD Annual Use-of-Force Report, 2016. https://www1.nyc.gov/assets/nypd/downloads/pdf/use-of-force/use-of-force-2016.pdf. Published 2017. Accessed July 14, 2018.

22. Philadelphia Police Department (PDP). Officer Involved Shootings. https://www.phillypolice.com/ois/. Published 2018. Accessed July 14, 2018.

23. Los Angeles Police Department (LAPD). Use of Force Year-End Review, 2016. http://assets.lapdonline.org/assets/pdf/2016-use-of-force-year-end-review-small.pdf. Published 2017. Accessed July 14, 2018.

24. Nieuwenhuys A, Savelsbergh GJ, Oudejans RR. Shoot or don't shoot? Why police officers are more inclined to shoot when they are anxious. *Emotion.* 2012;12(4):827.

25. White MD. Hitting the target (or not): Comparing characteristics of fatal, injurious, and noninjurious police shootings. *Police Quarterly.* 2006;9(3):303-330.

26. Bolger PC. Just following orders: a meta-analysis of the correlates of American police officer use of force decisions. *American Journal of Criminal Justice.* 2015;40(3):466-492.

27. Rydberg J, Terrill W. The effect of higher education on police behavior. *Police Quarterly*. 2010;13(1):92-120.

28. McElvain JP, Kposowa AJ. Police officer characteristics and the likelihood of using deadly force. *Criminal Justice and Behavior.* 2008;35(4):505-521.

29. Paoline III EA, Terrill W. Police education, experience, and the use of force. *Criminal Justice and Behavior.* 2007;34(2):179-196.

30. Ridgeway G. Officer risk factors associated with police shootings: a matched case–control study. *Statistics and Public Policy.* 2016;3(1):1-6.

31. Lersch KM, Mieczkowski T. Violent police behavior: past, present, and future research directions. *Aggression and Violent Behavior.* 2005;10(5):552-568.

32. Reingle Gonzalez JM, Bishopp SA, Jetelina KK, Paddock EM, Gabriel KP, Cannell MB. Does military veteran status and deployment history impact officer involved shootings? A case-control study. *Journal of Public Health.* Pending publication.

33. Ross CT. A multi-level Bayesian analysis of racial bias in police shootings at the county-level in the United States, 2011–2014. *PLoS One.* 2015;10(11):e0141854.

34. Scott K, Ma DS, Sadler MS, Correll J. A social scientific approach toward understanding racial disparities in police shooting: data from the Department of Justice (1980–2000). *Journal of Social Issues.* 2017;73(4):701-722.

35. Geller WA, Karales KJ. Shootings of and by Chicago police: uncommon crises part I: shootings by Chicago police. *The Journal of Criminal Law and Criminology (1973-).* 1981;72(4):1813-1866.

36. FitzGerald SC, Bromley ML. Surviving deadly force encounters: a case study. *Journal of Police and Criminal Psychology.* 1998;13(2):25-35.

37. Donahue ME, Horvath FS. Police shooting outcomes: suspect criminal history and incident behaviors. *American Journal of Police.* 1991;10:17.

38. Strote J, Verzemnieks E, Walsh M, Hutson HR. Use of force by law enforcement: an evaluation of safety and injury. *Journal of Trauma and Acute Care Surgery.* 2010;69(5):1288-1293.

39. Coben JH, Steiner CA. Hospitalization for firearm-related injuries in the United States, 1997. *American Journal of Preventive Medicine.* 2003;24(1):1-8.

40. Fowler KA, Dahlberg LL, Haileyesus T, Annest JL. Firearm injuries in the United States. *Preventive Medicine.* 2015;79:5-14.

41. Kellermann AL, Rivara FP, Lee RK, et al. Injuries due to firearms in three cities. *New England Journal of Medicine.* 1996;335(19):1438-1444.

42. Cook PJ, Lawrence BA, Ludwig J, Miller TR. The medical costs of gunshot injuries in the United States. *JAMA.* 1999;282(5):447-454.

43. Spitzer SA, Staudenmayer KL, Tennakoon L, Spain DA, Weiser TG. Costs and financial burden of initial hospitalizations for firearm injuries in the United States, 2006–2014. *American Journal of Public Health.* 2017;107(5):770-774.

44. Lee H, Vaughn MS. Organizational factors that contribute to police deadly force liability. *Journal of Criminal Justice.* 2010;38(2):193-206.

45. Lyons K, Radburn C, Orr R, Pope R. A profile of injuries sustained by law enforcement officers: A critical review. *International Journal of Environmental Research and Public Health.* 2017;14(2):142.

46. Carlier IV, Lamberts RD, Gersons BP. Risk factors for posttraumatic stress symptomatology in police officers: a prospective analysis. *The Journal of Nervous and Mental Disease.* 1997;185(8):498-506.

47. Chopko BA. Posttraumatic distress and growth: An empirical study of police officers. *American Journal of Psychotherapy.* 2010;64(1):55-72.

48. Geller A, Fagan J, Tyler T, Link BG. Aggressive policing and the mental health of young urban men. *American Journal of Public Health.* 2014;104(12):2321-2327.

49. Pickering JC, Klinger DA. Enhancing police legitimacy by promoting safety culture. In: *The Politics of Policing: Between Force and Legitimacy.* Emerald Group Publishing Limited; 2016:21-39.

50. Desmond M, Papachristos AV, Kirk DS. Police violence and citizen crime reporting in the black community. *American Sociological Review.* 2016;81(5):857-876.

51. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. *Source Code for Biology and Medicine.* 2008;3(1):17.

52. Hosmer Jr DW, Lemeshow S, Sturdivant RX. *Applied Logistic Regression.* Vol 398: John Wiley & Sons; 2013.

53. Midi H, Sarkar SK, Rana S. Collinearity diagnostics of binary logistic regression model. *Journal of Interdisciplinary Mathematics.* 2010;13(3):253-267.

54. Hubbard AE, Ahern J, Fleischer NL, et al. To GEE or not to GEE: comparing population average and mixed models for estimating the associations between neighborhood risk factors and health. *Epidemiology*, 2010;21(4):467-474.

55. Bagley SC, White H, Golomb BA. Logistic regression in the medical literature: standards for use and reporting, with particular attention to one medical domain. *Journal of Clinical Epidemiology.* 2001;54(10):979-985.

56. Dong Y, Peng C-YJ. Principled missing data methods for researchers. *SpringerPlus.* 2013;2(1):222.

57. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*. 2007;39(2):175-191.

58. United States Census Bureau. Quickfacts: Dallas city, Texas. https://www.census.gov/quickfacts/fact/table/dallascitytexas/PST045217. Updated 2017. Accessed November 8, 2018.

59. Dallas Police Department. 2016 Racial Profiling Report. http://www.dallaspolice.net/reports/Shared%20Documents/2016_Racial_Profiling_Report.pdf. Published 2017. Accessed November 8, 2018.

60. Vila BJ, Morrison GB. (1994). Biological limits to police combat handgun shooting accuracy. *American Journal of Police*. 1994;13(1):1-30.

61. Copay AG, Charles MT. Handgun shooting accuracy in low light conditions: the impact of night sights. *Policing: An International Journal of Police Strategies & Management*. 2001;24(4):595-604.

62. Rostker BD, Hanser LM, Hix WM, et al. Evaluation of the New York City police department firearm training and firearm discharge review process. RAND Corporation; 2008. http://www.nyc.gov/html/nypd/downloads/pdf/public_information/RAND_FirearmEvaluation.pdf. Accessed November 8, 2018.

63. Brandl, S. G. (2017). Chapter 3: The Characteristics and Structure of Police Organizations. *Police in America*: 45,52-54. SAGE Publications.

64. Paoline EA. Police culture. *Encyclopedia of Criminology and Criminal Justice.* https://link.springer.com/referenceworkentry/10.1007%2F978-1-4614-5690-2_394. Published 2014. Accessed November 9, 2018.

65. Williams JJ, Westall D. SWAT and non-SWAT police officers and the use of force. *Journal of Criminal Justice.* 2003;31(5):469-474.

66. Centers for Disease Control and Prevention. Nonfatal occupational injuries and illnesses among older workers—United States, 2009. *Morbidity and Mortality Weekly Report*. 2011;60(16):503-508.

67. Engel RS, Smith MR. Perceptual distortion and reasonableness during police shootings: Law, legitimacy, and future research. Criminology & Public Policy, 2009;8(1):141-151.

68. Homant RJ, Kennedy DB, Hupp RT. Real and perceived danger in police officer assisted suicide. *Journal of Criminal Justice.* 2000;28(1):43-52.

69. Payne BK. Prejudice and perception: The role of automatic and controlled processes in misperceiving a weapon. *Journal of Personality and Social Psychology.* 2001;81(2):181-192.

70. Telles EE, Lim N. Does it matter who answers the race question? Racial classification and income inequality in Brazil. *Demography*. 1998;35(4):465-474.