Firearm-related morbidity and mortality by injury intent:

Analysis of medical, criminal, and vital records in Seattle, WA

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Abstract

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Epidemiology

Background: Due to the reliance on administrative records in firearm injury research, individual studies do not present an integrated picture of firearm injuries. Non-fatal and fatal injuries are frequently studied separately, as are injuries of different intents. Certain risk factors for assault-related firearm injuries, like characteristics of the neighborhoods where they occur, the injured person's involvement with criminal activity, or their mental health may also indicate an increased risk of self-inflicted, unintentional, or legal intervention firearm injury. However, identifying differences or similarities between intent-specific firearm injury groups requires the inclusion of all intent-specific firearm injuries, fatal and non-fatal, in a single study, using all available data, to present a more integrated picture of firearm injury. Clarifying the specific associations

between firearm injury risk factors and assault-related, self-inflicted, unintentional, and legal intervention firearm injuries can inform targeted interventions.

Methods: This study clarifies risk markers for intent-specific firearm injury both at the neighborhood level and the individual level.

To examine relations between neighborhood-level characteristics and rate/density of intent-specific firearm injury, we conducted an ecological study of firearm injuries in Seattle from 2005-2014, geocoded by residence (for injury rates) and occurrence locations (for injury densities). Using the Seattle Neighborhoods and Crime
Survey, counts of intent-specific firearm injuries per census tract were modeled as a function of "code of the streets," fear of crime, handgun ownership, and negative opinions of police, adjusted for neighborhood disadvantage.

To examine relations between arrest history and risk of intent-specific firearm injury, we used a case-control study to compare 10-year arrest histories of individuals with intent-specific firearm injuries to a control group of motor vehicle passengers with unintentional injuries in Seattle. All initial injuries occurring 2005-2014 among adults (21+ years) were included.

To examine relations between arrest, substance use disorder, and mental disorder histories and risk of intent-specific firearm injury we used a case-control study to compare two-year diagnosis and arrest histories of intent-specific firearm injury patients (cases) to unintentionally injured motor vehicle collision (MVC) passengers (controls). We included all initial fatal and non-fatal firearm and MVC injuries occurring 2010-2014 in Seattle or to Seattle residents, limited to individuals ages 13+.

For both case-control studies hospital and death records were probabilistically linked to statewide arrest and (for the second case-control study) hospitalization records. Multinomial logistic regression was used to compare odds of each arrest or diagnosis-related exposure among intent-specific firearm injury cases relative to controls, adjusting for age, race, and gender.

Results: Based on 1368 firearm injuries occurring in Seattle 2005-2014, we found specific neighborhood characteristics were associated with the rate/density of different intent-specific firearm injury categories, including associations with neighborhood scores on "code of the streets," fear of crime, handgun ownership, and negative opinions of the police.

In examining the 10-year arrest history of 1211 adult firearm injury cases and 522 controls, we found individuals with assault-related or legal intervention firearm injuries were more likely than controls to have been arrested for a variety of crimes, including drug-related felonies and violent crimes. Individuals with self-inflicted firearm injury were less likely than controls to have a history of felony arrests but were more likely to have an arrest history involving firearms. We found no significant differences in 10-year arrest history between individuals with unintentional firearm injury and controls.

In examining the 2-year arrest, substance use disorder, and mental disorder diagnoses of 763 firearm injury cases and 335 controls ages 13+, we found no significant differences between unintentional and self-inflicted firearm injury cases and controls. Assault-related firearm injury cases were more likely than controls to have a prior felony record, regardless of prior substance use or mental disorder diagnoses. Legal intervention firearm injury cases were more likely than

controls to have had a prior felony arrest as well as a diagnosis involving alcohol use, cannabis use, depression, psychosis, or conduct disorder.

Conclusions: Intent-specific firearm injuries display distinct patterns of association with neighborhood characteristics as well as individual-level arrest, substance use disorder, and mental disorder histories. Associations with neighborhood characteristics vary when examining place of occurrence versus place of residence, suggesting place-based interventions should consider place of residence and place of occurrence separately. Subjects with different intent-specific firearm injuries have distinct patterns of prior substance use, mental disorder, and arrest. Many of these injuries occurred after a series of prior encounters with law enforcement and medical professionals, suggesting these prior encounters are underutilized settings for firearm injury prevention programs.

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Lastly, I want to dedicate this dissertation to the two women who are directly responsible for it – Ursula Boll, who knew I would get a PhD before I did, and Lise Fried, who told me it would be in epidemiology.

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Introduction

In 2015, 121,249 people in the United Sates were shot, and 36,252 of those injuries were fatal.(1) If those injuries occurred at a steady rate, it would equate to a firearm injury every 5 minutes, and four firearm fatalities every hour. The burden of firearm injuries in the United States is unique; the firearm death rate alone is 10 times higher than rates in 22 other high income countries.(2) It is also an expensive burden; costing the United States an estimated $174 billion dollars a year.(3)

Notably, this burden of firearm injuries affects a wide variety of people across the United States when injuries of different intents are examined together. Firearm assaults and homicides (intentional shootings by another person) are most common in young men, particularly African American young men, in urban areas.(4) Self-inflicted firearm injuries and suicides (intentional shootings to oneself) are most common in older men, especially Caucasian men, in rural areas.(4,5) Unintentional shootings, whether the injury is inflicted by oneself or by someone else, have a bimodal distribution that seems split between young, urban men and older, rural men.(6,7) Legal intervention firearm injuries (caused by police during law enforcement activities) are too uncommon in both occurrence and as a specific research topic to have a strong demographic profile; the literature focuses on shootings of American Americans(8–10) and of individuals dealing with a mental health crisis.(11–15)

A key challenge of descriptively differentiating between firearm injuries of different intent is the reliance on administrative records to conduct firearm injury research. In practice, this has generally limited studies to a single data source, either hospital-based or death record-based, and also to focusing on either non-fatal or fatal injuries, but not both. Firearm injury studies have also generally focused on either a single intent group, like assault, or aggregated all the intent

groups together and focused on the overall mechanism of firearm injury. As in any research area, different studies are conducted in different populations, with different exposure and outcome definitions, and different statistical methods. For this reason, it is difficult to quantify the associations between a certain risk factor, like “substance use,” which may be associated with multiple forms of firearm injuries. By looking at intent groups in one study, we can clarify what are common and unique risk factors for specific forms of firearm injuries.

The purpose of this dissertation was to help quantify how risk factors for one form of firearm injury may also contribute to or indicate risk for other forms of firearm injury, in order to present a more integrated picture of firearm injuries. To achieve this, it was essential to compare intent groups in a single population, include both fatal and non-fatal injuries, contextualize injuries geographically and as part of a series of contacts with law enforcement and medical institutions, and use all the data available. With all that in mind, the aims of this dissertation were:

Aim 1

- How do geographic patterns of firearm injuries in Seattle differ between intent categories?
- What neighborhood characteristics are associated with intent-specific firearm injuries?
- Are these associations the same based on where injuries occur and where victims live?

Aim 2

- How do arrest histories differ between individuals with intent-specific firearm injuries and controls?

Aim 3

- How do substance use and mental disorder histories differ between intent-specific firearm injuries and controls?
- Are these associations independent of associations between prior arrests and intent-specific firearm injury?

I drew from an array of data sources to answer these study questions, including the Harborview Trauma Registry and Washington State death records to identify study subjects, Harborview Medical Center patient charts and online media archives for location data, the Seattle

Neighborhoods and Crime Survey and US Census data to characterize Seattle neighborhoods, and Washington State arrest and hospitalization records to look at arrest and diagnoses prior to injury. The probabilistic data linkage process necessary to link records across these sources is described in the Appendix.

Each chapter of the dissertation examines a different aspect of firearm injuries in Seattle, quantifying different patterns in ecological and individual risk markers for firearm injury, using administrative data to identify directly accessible points of intervention for law enforcement and medical professionals interested in preventing firearm injuries. The methods and data sources used in this dissertation were chosen so that results would be straightforward to replicate in other communities. However, they preclude causal inference, and none of the identified associations should be interpreted as causal without additional research.

Chapter 1. Neighborhood characteristics and intent-specific firearm injuries by residence and occurrence location: An ecological study

ABSTRACT

Little is known about the relationships between neighborhood characteristics and firearm injuries of different intent. Neighborhoods at high risk for assault-related firearm injuries may not be at high risk for self-inflicted, unintentional, or legal intervention firearm injuries.

To examine relations between neighborhood-level characteristics and rate/density of intent-specific firearm injury, we conducted an ecological study of firearm injuries in Seattle from 2005-2014, geocoded by residence (for injury rates) and occurrence locations (for injury densities). Using the Seattle Neighborhoods and Crime Survey, counts of intent-specific firearm injuries per census tract were modeled as a function of "code of the streets," fear of crime, handgun ownership, and negative opinions of police, adjusted for neighborhood disadvantage.

Specific neighborhood characteristics were associated with the rate/density of different intent-specific firearm injury categories, including associations between higher neighborhood scores on "code of the streets" and higher rates of assault-related firearm injury (incidence rate ratio (IRR) 1.35, 95% confidence interval (CI) 1.11-1.66), and increased density of legal intervention shootings in neighborhoods with more negative opinions of police (density ratio (DR) 1.77, 95% CI 1.32-2.38). Neighborhood handgun ownership was associated with unintentional firearm injury rates (IRR 1.19, 95% CI 1.03-1.39). Higher levels of neighborhood fear of crime were associated with

increased density of self-inflicted injuries (DR 1.50, 95% CI 1.20-1.86).

Assault-related, self-inflicted, unintentional, and legal intervention firearm injuries are each associated with specific modifiable neighborhood characteristics. Place-based interventions should consider place of residence and place of occurrence separately, and treat injury intent categories as distinct forms of firearm injuries.

INTRODUCTION

In 2014 an estimated 115,000 people were shot in the United States.(1) These injuries were not uniformly distributed across the population. The risk of a firearm injury (and whether the injury is assault-related, self-inflicted, unintentional, or due to legal intervention) varies based on a person's age, race, and location.(4,16)

Firearm assaults are particularly concentrated among high-risk individuals living in high-risk places – "hot people" in "hot spots."(17) The underlying environmental context of these "hot spots" shapes the risk to individuals within them. Neighborhood blight, the number of alcohol outlets, concentrated disadvantage, and neighborhood demographics all influence risk of firearm assault.(18–22) Less is known about the relationships between neighborhood characteristics and non-assault-related firearm injuries. Neighborhoods at high risk for assault-related firearm injuries may not be at high risk for self-inflicted, unintentional, or legal intervention firearm injuries, as these different intent groups represent fundamentally different injury circumstances. However, it is likely that neighborhood characteristics are associated with forms of firearm injury beyond assault. There are neighborhood measures of poverty that are associated with increased risk of both firearm suicide and homicide.(23) Concentrated disadvantage in neighborhoods is associated with overall homicide(21,24) and suicide rates.(25,26) Studies have also found associations between neighborhood demographic characteristics, including race, and violence(24,27), street culture norms(27,28), access to firearms(29), and fear of crime.(30)

Perceived neighborhood characteristics are key to understanding how "hot spots" contribute to firearm injury. In addition to showing strong associations with gun violence at the community level,(31,32) neighborhood perceptions can shape residents' mental health.(33) Perceptions of

place reflect and shape behavior and social norms, contributing to violence and injury as individuals act and react based on their perceptions of what is normal and appropriate.(34)

It is unknown if neighborhood characteristics associated with a specific form of firearm injury, like assault, are also associated with other forms of firearm injury because most studies of firearm injuries focus on a specific intent, such as firearm suicides(35,36) or homicides.(37,38) Few studies directly compare risk factors for intent-specific firearm injuries.(39) Including multiple intent categories as separate outcomes in a study offers a more nuanced understanding of which risk factors are common to all forms of firearm injury and which risk factors might be most strongly associated with a specific intent.

As an additional complexity, in many studies neighborhood of residence is used as a proxy for neighborhood where injuries occur. At geographic levels more granular than county, these are frequently distinct locations.(20,40,41) Separately examining residence and occurrence locations would allow for distinguishing between the rate of injuries (based on neighborhood population) and density of injuries (based on geographic area). Firearm injuries that occur in a given neighborhood do not necessarily involve residents of that neighborhood. Rates of injuries in neighborhoods with a small number of residents but a large number of visitors may be subject to overestimation.(42) Residence location and occurrence location may both contribute to risk of injury, one through long-term environment and the other through the immediate circumstances of an injury.

We conducted an ecological study of neighborhood characteristics and intent-specific firearm injuries in Seattle, Washington, USA based on all firearm injuries, both fatal and non-fatal, over a 10-year period geocoded by residence and occurrence locations. Using four pre-specified neighborhood characteristics hypothesized to be associated with firearm injury, namely “code of

the streets" (rules regarding the threat and use of violence,(43) see Methods for more detail), fear of crime, handgun ownership, and negative opinions of the police, we compared relative rates and densities of assault-related, self-inflicted, unintentional, and legal intervention firearm injuries in 123 neighborhoods in Seattle. Firearm injuries of differing intent occur at notably different rates, and are fatal in different proportions.(6) Our goal in this study was to determine whether injury intent categories represent distinct forms of firearm injury, with divergent neighborhood-level risk factors characterizing both where injury subjects resided and where they were injured.

METHODS

Data sources and subject identification

Data for this study were derived at the individual level and aggregated to the census tract level. Firearm injuries treated at Harborview Medical Center (HMC), the regional Level I trauma center, were abstracted from the HMC Trauma Registry based on mechanism (International Classification of Disease (ICD)-9 external cause of injury codes E922.xx, E955.xx, E965.xx, E970, E979.4, and E985.xx). Information on firearm injury deaths was abstracted from Washington State death certificate data based on cause of death (ICD-10 codes W32-34, X72-74, X93-95, Y22-24, Y35-36, and Y89). A probabilistic linkage algorithm based on first and last name, middle initial, date of birth, last four digits of their Social Security Number (SSN), and injury date was used to combine duplicate records across data sources.

The geographic location where each firearm injury occurred and the residential address of each injured person were identified based on HMC and death certificate data. Both addresses were geocoded, and injuries were included in the study if the injury occurred in Seattle or the injured person resided in Seattle. To maximize data available across both sources, fatal and non-fatal

firearm injuries occurring between April 1, 2005 and December 31, 2014 were included in the study. All injuries that met inclusion criteria were aggregated to the census tract level based on place of residence and place of occurrence using the 123 residential Seattle census tracts from the 2000 Census.

Study protocol and procedures were approved by the University of Washington Institutional Review Board and the Washington State Institutional Review Board.

Outcome variables

Firearm injuries were categorized as assault, self-inflicted, unintentional, or legal intervention based on ICD-9 and ICD-10 external injury codes (Supp. Table 1.1). When medical records and the death certificate disagreed on intent categorization for fatal injuries, death certificate coded intent was used. We assumed that initial confusion over intent in a treatment setting was corrected by further investigation into a fatal injury, as nine out of the 14 injuries with non-matching codes changed from "undetermined" to a specific intent coding. Injuries where intent could not be determined were excluded (20/1098 coded by residence or 14/885 coded by occurrence). Summary counts of injuries by each intent category were aggregated at the census tract level using Census 2000 boundaries. Aggregated by the census tract where each injury subject *resided* were: (1) assault- and homicide-related firearm injuries, (2) self-inflicted or suicide firearm injuries, (3) unintentional firearm injuries, and (4) firearm injuries due to legal intervention. These count variables were also aggregated by the census tract where each injury *occurred*, resulting in eight total variables. Maps of Seattle census tracts showing counts of each form of firearm injury by residence tract and occurrence tract were produced (see Figures 1.1 and 1.2) and annual incidence calculated (Figure 1.3).

Exposure variables

The Seattle Neighborhoods and Crime Survey (SNCS) was used to define neighborhood characteristics of interest. The SNCS surveyed opinions and attitudes about neighborhood norms from a randomly selected sample of households in a multilevel, representative survey conducted within Seattle census tracts in 2002 and 2003. A detailed description of the SNCS methodology and list of related publications is available in the Appendix. The full dataset is accessible through the Inter-university Consortium for Political and Social Research.(44)

We chose “code of the streets”, resident’s fear of crime, handgun ownership, and negative opinions about the police as neighborhood characteristics of interest. While we did not expect all four characteristics to be associated with all forms of firearm injury, we evaluated each potential association and considered exposure-outcome pairings where we did not expect to find an association as negative controls. That is, the inclusion of exposure-outcome pairings where we do not expect to find associations can help detect bias if an unexpected association is identified.(45) “Code of the street” refers to a set of norms governing interpersonal violence in neighborhoods marked by low socioeconomic status, distrust of institutional authority, and high levels of criminal activity. Originally coined by Anderson(46) to describe localized adaptation to a lack of faith in police and the judiciary, the “code” puts high value on retaliation and a reputation for aggression and self-protection. Higher scores on “code of the streets” (range 5-20) indicate stronger endorsement for the practice of these norms in a neighborhood. It was hypothesized that neighborhoods where residents endorse adherence to the code may have higher rates of firearm assaults among individuals using violence to resolve disputes. “Fear of crime” included fear of physical attack and property crime. Higher scores indicate greater fear among neighborhood residents (range 3-12 points). Fear of crime has been linked to gun carrying(29,47) which is associated with increased risk of firearm assault(48) and unintentional firearm injuries.(47) “Handgun ownership” represented the percentage of residents who reported owning a handgun. Research has established associations between handgun

ownership and firearm homicide and suicide at the household(49,50) and population level.(4) "Negative opinions about the police" included doubts about police effectiveness, racial profiling, and trust in the criminal justice system. A higher score (range 5-19 points) indicates a more negative view of police. Although mistrust in police is related to the "code of the streets," we chose to highlight it separately as the topic of relations between communities and law enforcement agencies is of national interest.

Responses to questions relating to these neighborhood characteristics were abstracted from 2,205 survey responses, averaged within each census tract, and summed, generating a tract-level score on each characteristic. Tracts were divided into quintiles for each score and treated as ordinal variables. Details are available in Supplementary Materials.

Covariates

As measures of neighborhood disadvantage may increase risk of firearm injury and also contribute to neighborhood norms, we created a neighborhood disadvantage index to adjust for confounding by neighborhood disadvantage while conserving statistical power. Census estimates of the percentage of persons living below the poverty line, percentage of persons on public assistance, percentage of unemployed persons over age 16, percentage of persons under age 18, percentage of African American residents, and percentage of female-headed households per census tract were combined into a concentrated disadvantage index using principal components analysis.(51) African American resident percentage was included to adjust for the known association between neighborhood racial demographics and the "code of the streets"(28) in the SNCS. As exposure data were collected in 2002-2003, Census 2000 estimates were used in order to adjust for potential confounding by pre-existing disadvantage. To account for expected differences in counts of injuries between tracts with more residents, we included mean tract population between 2005 and 2014 from the American Community Survey

as an offset term when modeling counts of firearm injuries sustained by residents. To account for expected differences between census tracts of varying size we included land area of the tract as an offset term when modeling counts of injuries occurring in a tract.

Statistical Analysis

Counts of firearm injury types were presented descriptively based on median and interquartile range (IQR) to account for skewed distribution. Additionally, for persons who both resided and were injured in Seattle, distance between their injury location and residential location was calculated.

A staged approach to statistical modeling was taken in order to understand how the neighborhood characteristics were associated with firearm injuries individually, collectively, and after adjusting for neighborhood disadvantage. For stage 1, the association between each neighborhood characteristic and each outcome variable were modeled as separate, univariate estimates. In stage 2, all four neighborhood characteristics were included in a multivariable model. Stage 3 was identical to stage 2, with further adjustment for the neighborhood disadvantage index. Negative binomial regression with robust standard errors was used for all models to account for overdispersion in the data.

Data from the US Census and American Community Survey were accessed through the National Historical Geographic and Information System.(52) Probabilistic linkage between data sources was done using The Link King.(53) Locations were geocoded using the MapQuest Geocoding API (MapQuest, Denver, CO). Mapping and point-in-polygon geocoding of addresses to census tracts were done in ArcGIS (ESRI, Redlands, CA). Counts of firearm injuries per census tract were normalized by census tract population (for location of residence)

and census tract area in square meters (for location of occurrence). All statistical analyses were done using Stata 14 (StataCorp LP, College Station, TX).

RESULTS

Based on our inclusion criteria we geocoded 1368 firearm injuries to addresses within Seattle's 123 census tracts, including 1098 residential locations (80.3% of injuries) and 885 (64.7% of injuries) occurrence locations (Table 1.1). Using occurrence location identified 271 firearm injuries that occurred in Seattle to non-residents. A total of 615 firearm injury subjects had both a residential address and injury address within Seattle. While a majority of assault, unintentional, and legal intervention injuries could be attached to an address, only in 17% of self-inflicted injuries could an injury location be identified. In the subgroup of injuries where both residence and occurrence location could be identified, there were clear differences by injury intent in the distance between where a subject lived and where they were shot, with a median distance of 2.7 kilometers for assaults, zero kilometers for self-inflicted and unintentional injuries, and 2.6 kilometers for injuries related to legal intervention (Table 1.1). After aggregating injuries to the census tract level, we identified differences in counts of injuries per tract by intent. Assaults and homicides represented the majority of firearm injuries, with a median count of two per census tract between 2005 and 2014 using census tract of subjects' residence (IQR 0-6) or census tract of injury occurrence (IQR 0-9).

Maps of each neighborhood characteristic and the disadvantage index are available as Supplementary Figures 1.1-1.5. Neighborhood scores for adherence to "code of the streets" ranged from 6.6-13.3, with a mean of 8.8. Neighborhood scores on fear of crime ranged from 3.9-7.1, with a mean of 5.2. Neighborhood handgun ownership ranged from 0-43%, with a mean of 10%. Neighborhood scores for negative opinions about police ranged from 8.7-12.3, with a

mean of 10.1. Collinearity diagnostics found no evidence of notable collinearity among our exposure characteristics.

Maps comparing the spatial distribution of assault, self-inflicted, unintentional, and legal intervention firearm injuries based on subjects' census tracts of residence and census tracts of injury occurrence are shown in Figures 1.1 and 1.2. Both figures show differences between where firearm injury subjects lived and where firearm injuries occurred. Comparing across intent, Figure 1.1 shows a concentration of assault-related injuries in residents of Seattle's southeastern neighborhoods, a pattern not found in other forms of firearm injuries. Figure 1.2 shows a concentration of incidents in a very limited number of tracts. Annual incidence rates in Seattle (Figure 1.3) show low and stable rates of self-inflicted, unintentional, and legal intervention firearm injuries during the study period. Variation in overall firearm injury incidence is driven by the rate of assault-related injuries, which increased slightly during the study period.

Associations between neighborhood characteristics (linear by quintile) and rates of intent-specific firearm injuries are shown in Table 1.2a, based on subjects' residential address at the time of their injury. Rates of assault-related firearm injuries among residents were significantly associated with higher neighborhood scores on "code of the streets" (incidence rate ratio (IRR) 1.35, 95% confidence interval (CI) 1.11-1.66), handgun ownership (IRR 1.29, 95% CI 1.15-1.44), and negative opinions of the police (IRR 1.16, 95% CI 1.02-1.31) after adjusting for neighborhood disadvantage. Unintentional firearm injuries rates were significantly associated with higher neighborhood handgun ownership (IRR 1.19, 95% CI 1.03-1.39). Rates of legal intervention-related firearm injuries were significantly associated with higher neighborhood scores on negative opinions of the police (IRR 1.39, 95% CI 1.00-1.96).

Associations between neighborhood characteristics (linear by quintile) and relative density of intent-specific firearm injuries are shown in Table 1.2b, based on the location where injuries occurred. We found a significant association between density of assault-related firearm injuries and higher neighborhood scores on negative opinions of police, density ratio (DR) 1.55, 95% CI 1.22-1.95). There was a significant association between higher neighborhood fear of crime and density of self-inflicted injuries, DR 1.50, 95% CI 1.20-1.86. There was a significant association between density of legal intervention-related firearm injuries and higher neighborhood scores on negative opinions about the police, DR 1.77, 95% CI 1.32-2.38.

DISCUSSION

This study is among the first to describe differences between locations of residence and injury occurrence for firearm injuries, and to directly compare neighborhood characteristics associated with intent-specific forms of firearm injuries. Maps of firearm injuries by residence location and injury location show different spatial distributions of firearm injuries and vary by injury intent. Analyses of neighborhood characteristics found negative opinions about the police, adherence to “code of the streets,” higher rates of handgun ownership, and fear of crime were each associated with an increased rate or density of at least one firearm injury intent category.

Descriptively, our study found the spatial distribution of firearm injuries based on location of occurrence differs from the spatial distribution of firearm injury subjects’ residences. These differences vary by intent category. Spatial differences between tracts defined by residence and tracts defined by injury occurrence were less apparent for self-inflicted and unintentional firearm injuries, which are more likely to occur in the subject’s home,(54) and where the same person may be both subject and shooter. This supports other studies comparing injury and residence location for traumatic injuries more broadly, which have found differences between residence

and incidence location vary by injury mechanism, intent, and age group.(41,55) Taken together, these findings support the assertion that using residence in place of occurrence location can disguise injury hotspots.(55)

The strongest and most consistent association we identified was between neighborhood perceptions of police and rates/densities of assault-related and legal intervention firearm injuries. Census tracts where residents had more negative opinions about the police had higher rates of assault-related firearm injuries and legal intervention-related firearm injuries among their residents, and also experienced a greater density of both injury types occurring within the neighborhood. This finding is especially noteworthy as assault-related and legal intervention injuries were found to have the largest median distance between place of residence and place of occurrence. The distance between place of residence and place of occurrence is similar to a study of firearm assault in Miami.(20) For both assault-related and legal intervention injuries, residents of neighborhoods with more negative opinions about the police may be more likely to sustain such firearm injuries, and these injuries may be more likely to occur in neighborhoods with more negative opinions about the police, but these are not necessarily the same neighborhoods.

“Code of the streets,” handgun ownership rates, and fear of crime were each associated with higher rates of firearm injuries among residents, or with a higher density of injuries occurring in the neighborhood, but not both. Neighborhoods that scored higher on “code of the streets” and handgun ownership had higher rates of assault-related firearm injuries among their residents, but there was no evidence of a higher density of assault-related firearm injuries in those neighborhoods after adjusting for other factors. There was also evidence of a higher rate of unintentional firearm injuries among the residents of neighborhoods where gun ownership was more common. Conversely, the density of self-inflicted firearm injuries was greater in

neighborhoods where residents were more fearful of crime, but there was no evidence of an association between rates of self-inflicted injuries among residents and fear of crime. We did not find evidence of an association between higher rates of handgun ownership and self-inflicted injuries. This is puzzling, as gun ownership is well known to be associated with higher rates of firearm suicide.(35,49,50,56) This could be explained by underreporting of handgun ownership on the SNCS. Alternatively, this could represent an ecologic fallacy; personally owning a handgun increases one's likelihood of using it to attempt suicide, but even in neighborhoods with the highest reported rate of handgun ownership (43%) the majority of residents may not have direct access to a handgun.

The differences between rate of injury among residents and density of injuries in the neighborhood may be explained in part if we consider census tract of residence to represent long-term social context, i.e. chronic stressors, such as neighborhood disadvantage and disorder, while census tract of occurrence may represent more immediate circumstances surrounding an injury. Alternatively, place of occurrence may better reflect where a person spends the bulk of their time compared to their place of residence.

By combining records on firearm injury subjects who received medical treatment at Harborview with death records on those who died at the scene of their injuries, we were able to aggregate data on almost all firearm injuries in Seattle. Regional surveillance suggests that more than 85% of emergency department visits and 95% of hospitalizations for gunshot wounds occurring in Seattle are seen at HMC. We were also able to include occurrence locations as well as residential addresses. Our study has a clear temporal order between exposure (neighborhood characteristics) and outcomes (rates of firearm injuries), as we chose a study period that began collecting outcome data at least two years after our exposures were measured. Our

measurement of neighborhood characteristics was based on a representative sample of residents and reflects opinions and attitudes about neighborhood norms.

This study is subject to some limitations. It was conducted in a single urban area and aggregated firearm injuries over nearly a decade, potentially limiting generalizability and masking trends over time. However, a strong, long-term neighborhood effect on assault-related firearm violence has been found elsewhere,(20) supporting potential generalizability. Perceived neighborhood features and disadvantage measures may change over time. However, we found relative disadvantage based on 2000 and 2010 Census data strongly correlated (correlation coefficient 0.87). Past studies suggest relative neighborhood status and concentrated disadvantage are highly stable,(57,58) and neighborhood factors been found to be associated with health(59,60) and criminal behavior(61) over similar time frames. Not all injuries had residential or injury locations to be geocoded. As noted above, this was an ecologic study, subject to cross-level bias for the interpretation of constructs that have an individual-level counterpart. Our analyses based on where firearm injury subjects resided are not directly comparable to our analyses based on where firearm injuries occurred, as not every person who was shot in Seattle lived in Seattle, nor was every resident of Seattle who sustained a firearm injury shot within the city.

This study found that characteristics of the neighborhoods where firearm injury subjects lived and where they were shot were differentially associated with rates and densities of intent-specific firearm injuries. Place-based interventions should consider place of residence and place of occurrence separately, with appropriate care exercised in considering when to use residential address as a proxy for the location of injury occurrence.

Injury intent categories represent distinct forms of firearm injuries. Some neighborhood characteristics, such as negative opinions about the police, are associated with an increased rate of multiple forms of firearm injury. Disentangling risk factors related to the use of firearms as a mechanism of injury from risk factors related to injury intent will require studies directly comparing firearm injury intent groups.

Assault-related, self-inflicted, unintentional, and legal intervention firearm injuries are each associated with specific neighborhood characteristics that can be altered. By considering different forms of firearm injury separately, communities can implement place-based interventions tailored to the needs and priorities of “hot spot” neighborhoods.

TABLES AND FIGURES

Table 1.1. Firearm injury characteristics by intent in Seattle, 2005-2014

	Assault	Self-inflicted	Unintentional	Legal intervention	Total
Count of injuries geocoded by residential location (%)*^	670 (61.0)	298 (27.1)	82 (7.5)	28 (2.6)	1098 (100)
Count of deaths geocoded by residential location (%)*	159 (34.7)	278 (60.7)	4 (0.9)	12 (2.6)	458 (100)
Count of injuries geocoded by injury location (%)*^	700 (79.1)	69 (7.8)	69 (7.8)	33 (3.7)	885 (100)
Count of deaths geocoded by injury location (%)*	166 (70.0)	52 (21.9)	1 (0.4)	15 (6.3)	237 (100)
Count of injuries with both residential and injury location geocoded (%)*	463 (75.3)	64 (10.4)	53 (8.6)	22 (3.6)	615 (100)
Count of injuries with both residential and injury location geocoded (%)*	114 (64.4)	49 (27.7)	1 (0.6)	10 (5.7)	177 (100)
Median count per census tract, by residential location (IQR)	2 (0-6)	2 (1-3)	0 (0-1)	0 (0-0)	
Median count per census tract, by injury location (IQR)	2 (0-9)	0 (0-1)	0 (0-1)	0 (0-0)	
Median distance between injury location and residential location (km) (IQR)⊥	2.7 (0.5-7.0)	0 (0.0-0.5)	0 (0.0-4.1)	2.6 (0.3-7.6)	

*May not sum to 100% due to injuries with undetermined intent

^Includes both fatal and non-fatal injuries

⊥Based on subjects who resided and were injured in Seattle (N=615)

Table 1.2a. Regression estimates for census tracts based on residential location

		Model 1		Model 2		Model 3	
	Exposure	**IRR**	**(95% CI)**	**IRR**	**(95% CI)**	**IRR**	**(95% CI)**
Assault	Code of the streets	1.98	(1.76, 2.23)	1.69	(1.42, 2.00)	1.35	(1.11, 1.66)
	Fear of crime	1.46	(1.20, 1.78)	1.10	(0.94, 1.28)	1.05	(0.90, 1.23)
	Handgun ownership	1.23	(1.05, 1.44)	1.34	(1.16, 1.53)	1.29	(1.15, 1.44)
	Negative opinions of the police	1.68	(1.45, 1.95)	1.26	(1.09, 1.47)	1.16	(1.02, 1.31)
Self-inflicted	Code of the streets	1.06	(0.96, 1.18)	1.04	(0.90, 1.22)	1.09	(0.92, 1.28)
	Fear of crime	1.09	(0.97, 1.23)	1.10	(0.95, 1.27)	1.11	(0.96, 1.29)
	Handgun ownership	1.02	(0.91, 1.15)	1.01	(0.90, 1.14)	1.02	(0.91, 1.15)
	Negative opinions of the police	1.03	(0.92, 1.15)	0.94	(0.83, 1.06)	0.96	(0.85, 1.09)
Unintentional	Code of the streets	1.27	(1.07, 1.51)	1.17	(0.96, 1.43)	0.99	(0.79, 1.24)
	Fear of crime	1.21	(1.03, 1.43)	1.08	(0.91, 1.29)	1.04	(0.88, 1.24)
	Handgun ownership	1.19	(1.01, 1.40)	1.20	(1.03, 1.39)	1.19	(1.03, 1.39)
	Negative opinions of the police	1.22	(1.03, 1.44)	1.05	(0.87, 1.28)	0.99	(0.82, 1.20)
Legal intervention	Code of the streets	1.13	(0.86, 1.48)	0.85	(0.61, 1.18)	0.87	(0.60, 1.26)
	Fear of crime	1.22	(0.94, 1.59)	1.15	(0.87, 1.53)	1.15	(0.87, 1.53)
	Handgun ownership	1.21	(0.91, 1.61)	1.27	(0.96, 1.69)	1.28	(0.97, 1.68)
	Negative opinions of the police	1.43	(1.07, 1.91)	1.38	(0.99, 1.92)	1.39	(1.00, 1.95)

Model 1: each exposure as the single predictor in the model, offset by census tract mean population 2005-2014

Model 2: all 4 exposures, offset by census tract mean population 2005-2014

Model 3: all 4 exposures, adjusted for disadvantage index and offset by census tract mean population 2005-2014

*Exposures measured in quintiles. Incident rate ratios estimate the relative difference in rate of firearm injuries between neighborhoods differing by one quintile.

Table 1.2b: Regression estimates for census tracts based on injury occurrence location

		Model 1		Model 2		Model 3	
	Exposure	**DR**	**(95% CI)**	**DR**	**(95% CI)**	**DR**	**(95% CI)**
Assault	Code of the streets	2.26	(1.89, 2.72)	1.52	(1.23, 1.89)	1.20	(0.92, 1.57)
	Fear of crime	1.83	(1.50, 2.24)	1.14	(0.91, 1.43)	1.09	(0.86, 1.37)
	Handgun ownership	0.87	(0.68, 1.11)	1.06	(0.88, 1.26)	0.97	(0.82, 1.14)
	Negative opinions of the police	2.38	(1.92, 2.94)	1.72	(1.38, 2.15)	1.55	(1.22, 1.95)
Self-inflicted	Code of the streets	1.05	(0.85, 1.31)	0.81	(0.62, 1.07)	0.77	(0.57, 1.03)
	Fear of crime	1.35	(1.12, 1.62)	1.51	(1.21, 1.89)	1.50	(1.20, 1.86)
	Handgun ownership	1.08	(0.85, 1.37)	1.07	(0.84, 1.37)	1.06	(0.83, 1.36)
	Negative opinions of the police	1.12	(0.92, 1.37)	1.02	(0.81, 1.27)	0.99	(0.78, 1.26)
Unintentional	Code of the streets	1.52	(1.15, 2.00)	1.06	(0.80, 1.42)	0.93	(0.68, 1.29)
	Fear of crime	1.51	(1.15, 1.99)	1.19	(0.90, 1.57)	1.16	(0.87, 1.53)
	Handgun ownership	1.24	(0.98, 1.56)	1.20	(0.95, 1.51)	1.18	(0.94, 1.47)
	Negative opinions of the police	1.49	(1.14, 1.95)	1.40	(1.02, 1.91)	1.30	(0.94, 1.79)
Legal intervention	Code of the streets	1.30	(0.98, 1.71)	0.79	(0.61, 1.02)	0.72	(0.51, 1.03)
	Fear of crime	1.39	(1.06, 1.82)	1.22	(0.95, 1.57)	1.23	(0.96, 1.58)
	Handgun ownership	1.08	(0.84, 1.38)	1.18	(0.94, 1.48)	1.16	(0.91, 1.48)
	Negative opinions of the police	1.65	(1.27, 2.13)	1.84	(1.40, 2.43)	1.77	(1.32, 2.38)

Model 1: each exposure as the single predictor in the model, offset by census tract area in square meters

Model 2: all 4 exposures, offset by census tract area (m^2)

Model 3: all 4 exposures, adjusted by disadvantage index and offset by census tract area (m^2)

*Exposures measured in quintiles. Density ratios (DRs) estimate the relative difference in density of firearm injuries between neighborhoods differing by one quintile.

FIGURE 1.1. INCIDENCE RATE OF INTENT-SPECIFIC FIREARM INJURIES BY SEATTLE CENSUS TRACT OF RESIDENCE, 2005-2014

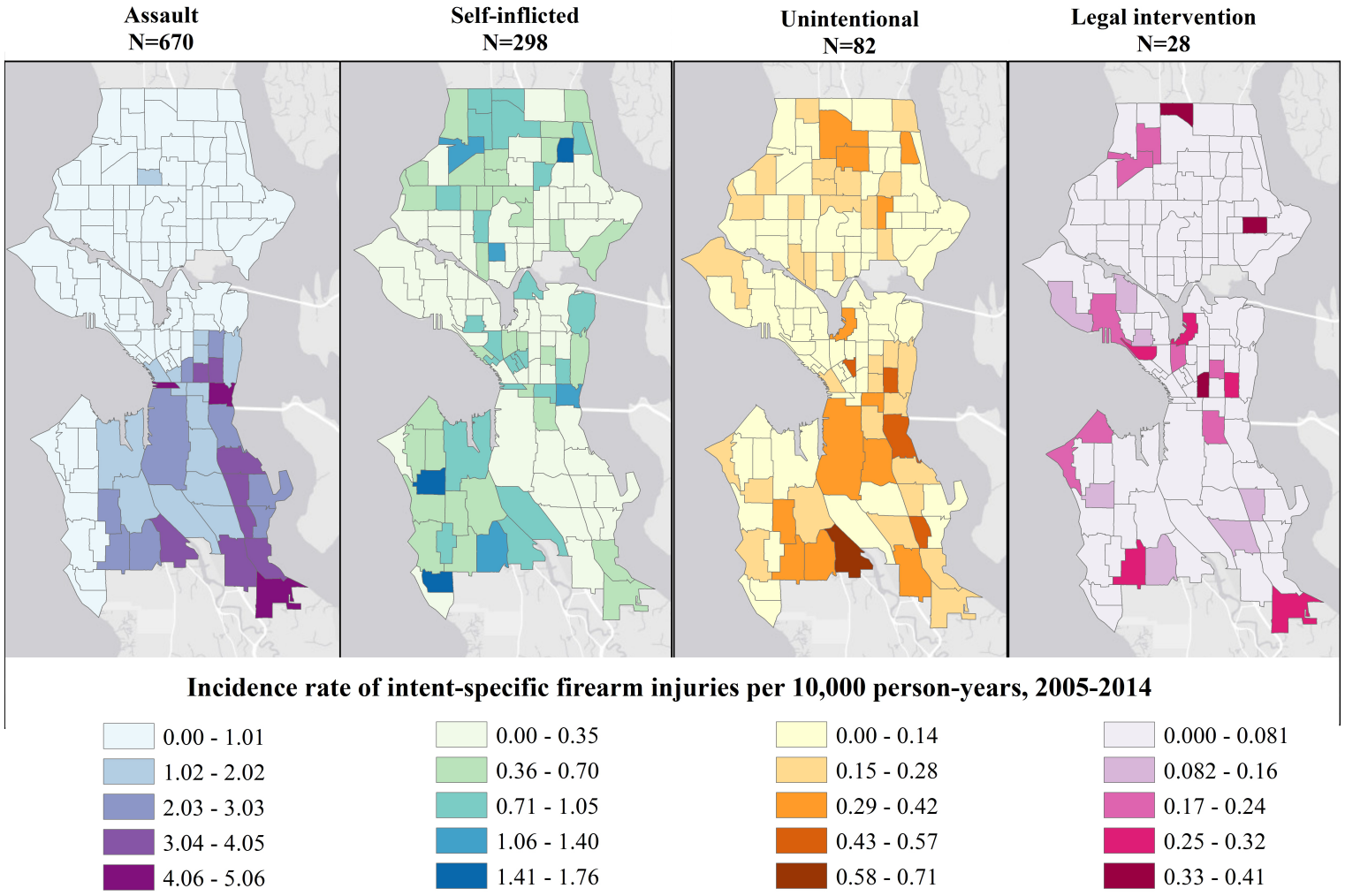


FIGURE 1.2. DENSITY OF INTENT-SPECIFIC FIREARM INJURIES BY SEATTLE CENSUS TRACT OF INJURY OCCURRENCE, 2005-2014

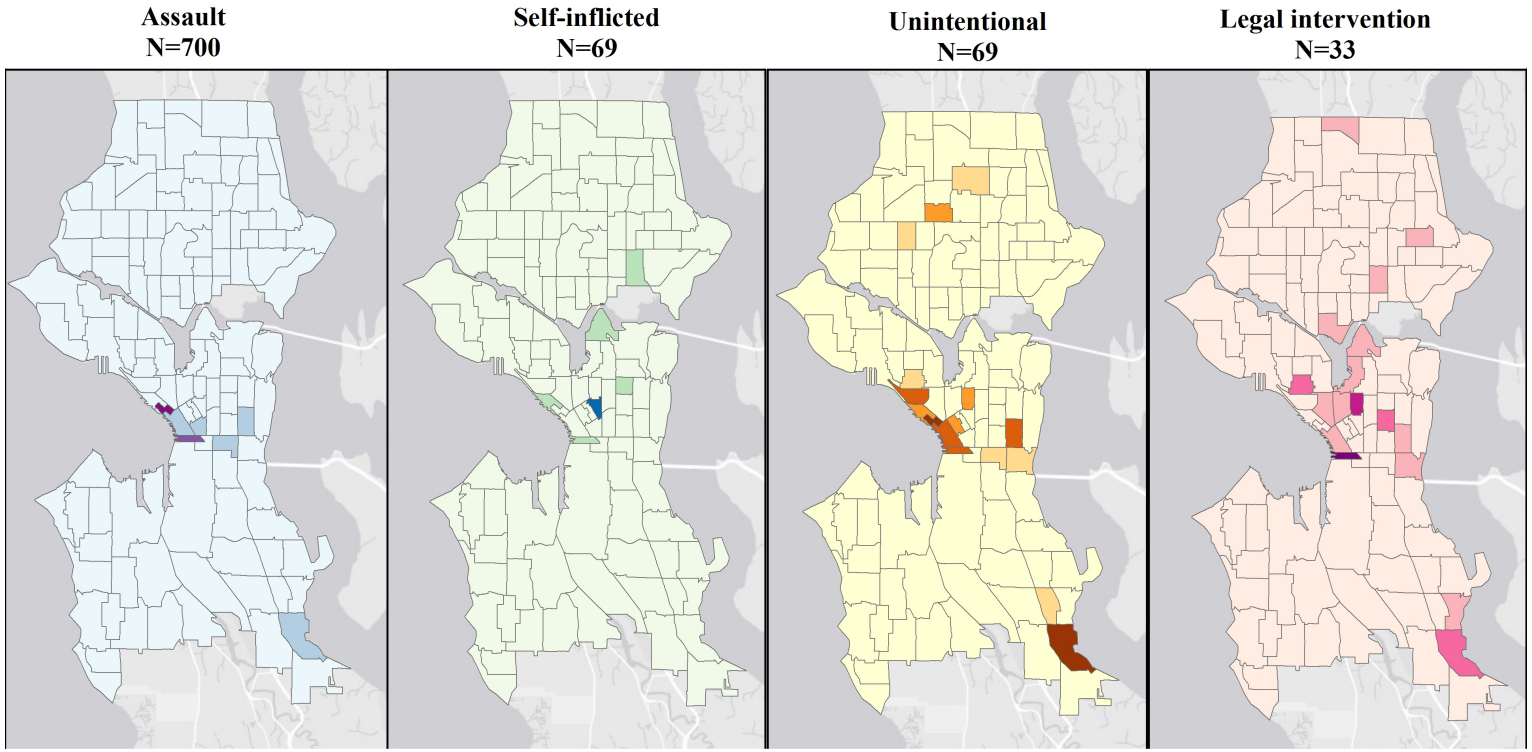
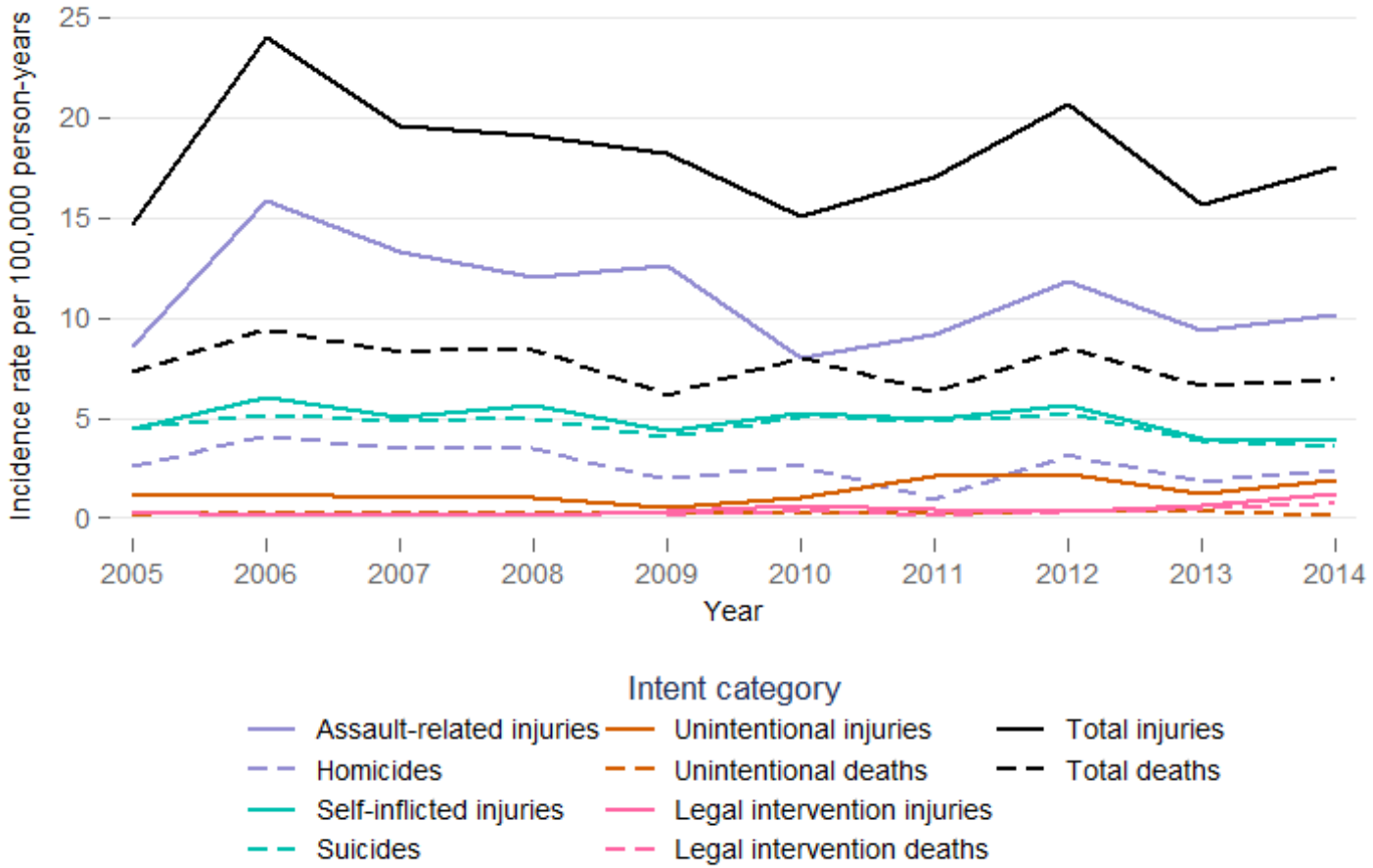


FIGURE 1.3. ANNUAL INCIDENCE OF INTENT-SPECIFIC FIREARM INJURIES IN SEATTLE, 2005-2014



"Injuries" include both fatal and non-fatal injuries

Chapter 2. Arrest history and risk of intent-specific firearm injury: A case-control study

ABSTRACT

Introduction: Criminal behavior and risk of firearm injury are interrelated. However, arrest histories of individuals with intent-specific firearm injuries (assault-related, self-inflicted, unintentional, and legal intervention) have not been studied jointly.

Methods: We compared arrest histories of individuals with intent-specific firearm injuries to a control group of motor vehicle passengers with unintentional injuries in Seattle. All initial injuries occurring 2005-2014 among adults (21+ years) were included. Hospital and death records were linked to 10-year arrest records in Washington State using probabilistic linkage. Multinomial logistic regression was used to quantify associations between specific crime types and odds of intent-specific firearm injury relative to odds of unintentional motor vehicle passenger injury.

Results: We identified 1211 firearm injury cases and 522 controls. Individuals with assault-related firearm injury were more likely than controls to have been arrested for a drug-related felony (OR 2.26, 95% CI 1.44-3.54) and violent crime (OR 1.74, 95% CI 1.13-2.67) after adjusting for age, gender, and race. Individuals with self-inflicted firearm injury were less likely than controls to have a history of non-drug-related (OR 0.21, 95% CI 0.09-0.45) and drug-related felony (0.22, 95% CI 0.11-0.45), but were more likely to have been arrested on firearms-related charges (OR 3.06, 95% CI 1.01-9.26). We found no significant differences in arrest history between individuals with unintentional firearm injury and controls.

Conclusions: Intent-specific firearm injuries display distinct patterns of association with arrest history. Disaggregating firearm injuries into intent-specific subgroups can improve the sensitivity of studies and inform appropriate public health and public safety interventions.

INTRODUCTION

In 2014 an estimated 114,633 firearm injuries occurred in the United States, including 33,599 deaths.(1) Including medical treatment and criminal investigations, the societal costs of gun violence exceed $174 billion per year.(3) The responsibility to reduce this combined burden of interpersonal violence (assaults and homicides), self-directed violence (intentional self-inflicted injuries and suicides), police-involved shootings (legal intervention firearm injuries), and unintentional shootings falls directly or indirectly to public health and law enforcement professionals.

Understanding gun violence as a topic of importance to both public health professionals and law enforcement officials has bolstered research investigating the interrelationships between violent perpetration and victimization. Interventions like focused deterrence blend public health perspectives with law enforcement resources.(62) Many individuals are involved in interpersonal violence as both victim and perpetrator.(63–65) Criminal behavior increases the risk of firearm injury, particularly assault-related firearm injuries.(66,67) Gun carrying, which is associated with criminal activity,(68,69) is also associated with increased risk of firearm assault(48) and potentially unintentional firearm injury.(47) Individuals with longer arrest records are more likely to have adverse health issues,(70) which are strongly associated with risk of suicide.(36)

Although studies have shown overlapping risk factors for firearm injuries of different intents,(4,56,71) the arrest histories of individuals with firearm injuries of varying intent have not previously been compared in a single population, nor to a proxy group for the general population. Disaggregating intent-specific firearm injuries in a single population allows for more sensitive analysis of subgroup relations, without the comparability issues involved in assessing results across multiple studies. In this study we compared the arrest history of individuals injured with a firearm categorized by injury intent to a control group of motor vehicle passengers

injured in the same area and time period. We sought to examine how individuals with firearm injuries compared to controls in terms of prior involvement in crime, and identify differences between intent groups in their arrest histories. We chose MVC passenger injuries as an available, hospital-based control group that best approximated the general population.

Using arrest records to identify relationships between specific types of crimes and specific forms of injuries may reveal similarities between intent groups in their arrest histories. Firearm possession, substance abuse, and impulsivity are all associated with increased risk of both assault(19,48,50,71–74) and self-inflicted firearm injuries(50,56,74–77) as well as gang membership.(69,78,79) However, other studies have found differences in adolescent trajectories of firearm violence perpetrators and non-perpetrators(80) and in the proportion of individuals with an arrest history in assault-related and self-inflicted injury groups.(81) Distinct, intent-specific patterns of arrest history would suggest law enforcement professionals have an important role in preventing self-inflicted and unintentional gun violence as well as assault-related and legal intervention firearm injuries.

METHODS

Data sources and subject identification

Study subjects were identified from the Harborview Medical Center (HMC) trauma registry and Washington State death certificates. Injuries treated at Harborview, the region's Level 1 trauma center, were abstracted based on International Classification of Disease (ICD)-9 external cause of injury codes for firearm-related (E922.xx, E955.xx, E965.xx, E970, E979.4, and E985.xx) or motor vehicle trauma (MVC)-related injuries (E810.xx-819.xx). Firearm- and MVC-related deaths were abstracted based on ICD-10 cause of death codes (W32-34, X72-74, X93-95, Y22-24, and Y35-36 for firearm-related deaths; V00-V79 for MVC injuries). MVC controls were

limited to unintentional injuries sustained by passengers in a motor vehicle based on ICD-9 codes ending in ".1," coded transportation role, or injury description.

As firearm injury subjects from several states are routinely seen at HMC for specialized care, we restricted to injuries occurring in Seattle and to Seattle residents based on ZIP code (981xx) to ensure cases and controls were drawn from the same population. The study was limited to the first fatal or non-fatal injury occurring between April 1, 2005 and December 31, 2014 (the longest span of time in which both injury and death records were available). As no arrest records were available for persons younger than 10, we excluded study subjects younger than 21 at the time of their injury to ensure that all subjects had equal exposure time. If a subject sustained both a firearm-related and an MVC passenger-related injury their firearm-related injury was used.

To avoid duplication, a probabilistic algorithm based on subjects' first and last name, middle initial, date of birth, gender, and the last four digits of the Social Security Number was used to link HMC records and death certificate records for study subjects who sustained fatal injuries. The same probabilistic algorithm used to link subjects' HMC and death records was also used to link subjects to arrest records from 1995-2014 contained in the Washington State Identification System criminal history database maintained by the Washington State Patrol (WSP). The WSP serves as the central repository for all arrest and disposition data in the state of Washington, aggregating data from local law enforcement agencies across the state.(82) Study protocol and procedures were approved by the University of Washington Institutional Review Board and the Washington State Institutional Review Board.

Outcome variable

Subjects were divided into subtype-specific cases and controls based on injury mechanism ICD-9 and -10 codes indicating mechanism of injury as firearm (cases) or motor vehicle (controls). Cases of firearm injury were sub-divided by injury intent into assault-related and homicide (E965.xx/X93-95), self-inflicted or suicide (E955.xx/X72-74), unintentional (E922.xx/W32-34), and legal intervention (E970/Y35-36). In total, the outcome variable had five categories – four intent-specific firearm injury groups and one group of MVC passenger controls.

Exposure variables

Each arrest in the ten years prior to each subject's injury was categorized based on the specific charges and flags noted by the WSP, excluding any arrest that occurred in the 48 hours immediately prior to injury. We focused on identifying specific types of arrests that may differ between case groups: arrests involving firearms or drugs, DUIs, and arrests for domestic violence. We also categorized arrests based on severity (misdemeanor or felony) and if the arrest was for an FBI-defined violent crime (rape, assault, homicide, or robbery).(83) Each subject's 10-year arrest history was then summarized using these same categories; for example, if they had ever been arrested for a violent crime, or only nonviolent crimes, or had no arrests in the previous ten years. Finally, to isolate any associations with gang activity, we categorized each subject's arrest history using a combination of severity and drug-involvement (history of non-drug-related misdemeanors, drug-related misdemeanors, non-drug-related felonies, or drug-related felonies). The specific Revised Criminal Code of Washington violations that define each exposure category are available in the Supplemental Materials.

Covariates

The risk of sustaining an intent-specific firearm-related injury varies based on age, gender, and race.(6) We therefore included age (continuous, in years), gender, and race as covariates in our final adjusted analyses.

Statistical Analysis

Multinomial logistic regression was used to estimate associations between our summary exposure variables and the five injury categories of our outcome variable. We ran four models to test for associations between specific "flagged" arrest types (firearms, drugs, DUIs, and domestic violence) and the relative odds of intent-specific injury. We ran two models to investigate if there was a dose-response relationship with risk of injury and severity of crime (misdemeanor or felony) and violent crime. Finally, we ran a model to investigate the specific associations between gang involvement (based on drug-related felony history), criminal violence, and firearm crime.

The four intent-specific firearm injury groups were compared to the referent category of MVC passenger injuries in all models. Models were run both as crude odds ratios (ORs) (available in Supplementary materials) and as multivariable models adjusted for age, gender, and race. All presented ORs can be interpreted as conditional ORs. For example, the OR presented for the association between prior arrest and assault-related firearm injury provides the ratio of odds of prior arrest conditional on having sustained either an assault-related firearm injury or MVC passenger injury. Probabilistic linkage between data sources was done using The Link King.(53) All statistical analyses were done using Stata 14 (StataCorp LP, College Station, TX).

RESULTS

Characteristics of the study population

We identified 2390 Seattle-based injuries that met our inclusion criteria (1549 initial firearm injuries, 841 initial MVC passenger injuries). Five individuals with both a firearm and an MVC passenger injury were included as firearm injury cases. After excluding 627 subjects under the

age of 21, our final study population was 1733 subjects (1211 firearm injuries and 522 MVC passenger injuries). A majority of firearm injuries were assault-related (57%), followed by self-inflicted (33%), unintentional (6%), and legal intervention (4%) (Table 2.1). The majority of firearm injury subjects were male. There were clear differences between each injury group in fatality proportions (from 5.6% to 90.3%), age at injury, and racial composition. Among those subjects who received medical treatment, we also found clear differences in socioeconomic status, based on insurance category.

Patterns of arrest among injury groups

A majority of subjects in the assault-related and legal intervention firearm injury groups had been arrested at least once in Washington State in the ten years prior to their injury (68.7 and 66.0%, respectively). The assault-related firearm injury group had the highest number of arrests in the ten years prior to their injury (9, interquartile range (IQR) 4-16) and all injury groups had outlier individuals with more than 20 arrests in a ten-year period (Figure 2.1). Plotting each subject's 10-year arrest history and color-coding each arrest by severity and whether it was drug-related (Figure 2.2) shows both the relatively high proportion of prior arrests in the assault-related injury group, and the higher frequency of drug-related felonies in this group. In each injury group we found individuals who had extensive arrest histories involving both misdemeanor and felony offenses, and both drug-related and non-drug-related arrests.

Multinomial analyses: Arrests involving firearms, drugs, DUIs, and domestic violence

The results of our multinomial analyses are presented in Table 2.2. Investigating the associations between our specific flagged arrests and injury group, after adjusting for age, gender, and race, subjects in the assault-related firearm injury group were significantly more likely than subjects in the unintentional MVC passenger injury control group to have had a prior

arrest involving firearms (OR 3.37, 95% CI 1.63-6.96), more likely to have a drug-related arrest record (OR 2.54, 95% CI 1.79-3.60), and more likely to have a record for domestic violence (OR 1.81, 95% CI 1.24-2.64). Subjects in the self-inflicted firearm injury group were less likely than MVC controls to have a drug-related arrest record (OR 0.38, (95% CI 0.22-0.66) after adjusting for age, gender, and race. Subjects in the legal intervention firearm injury group were more likely than MVC controls to have an arrest record for domestic violence (OR 2.28, 95% CI 1.08-4.83) after adjustment.

Multinomial analyses: Severity of crime

In our criminal severity model, we found no significant differences between any firearm injury group and controls in the likelihood of having a history of misdemeanor arrests. Subjects in both the assault-related and legal intervention firearm injury groups were more likely than MVC controls to have a history of arrest for felonies (OR 2.70, (95% CI 1.95-3.75 and OR 3.57, 95% CI 1.73-7.35, respectively) after adjustment. Subjects in the self-inflicted firearm injury group were less likely than MVC controls to have a history of felony arrest (OR 0.33, (95% CI 0.20-0.54).

Multinomial analyses: Violent crime

In our criminal violence model, subjects in both the assault-related and legal intervention firearm injury groups were more likely than MVC controls to have a history of arrest for violent crimes (OR 3.07, (95% CI 2.11-4.45 and OR 4.64, 95% CI 2.13-10.11, respectively) after adjustment. Subjects in the assault-related injury group were also more likely to have a prior history of arrest for nonviolent crimes, compared to MVC controls (OR 1.66, 95% CI 1.17-2.33). Subjects in the self-inflicted firearm injury group were less likely than MVC controls to have a history of arrest for nonviolent crime (OR 0.50, (95% CI 0.33-0.77) but were not significantly different from MVC controls in their history of arrest for violent crime.

Multinomial analyses: Gang involvement

Our gang involvement model, which stratified drug-related arrests by severity and included violent crime and firearms offenses in a multivariable analysis, found that subjects in the assault-related firearm injury group were not significantly different from MVC controls in their history of arrest for non-drug-related offenses or misdemeanor drug offenses, but were significantly more likely to have a history of arrest for drug-related felonies (OR 2.26, 95% CI 1.44-3.54) and more likely to have been arrested for violent crime (OR 1.74, 95% CI 1.13-2.67), after adjusting for age, gender, and race. Subjects in the legal intervention firearm injury group were more likely than MVC controls to have a history of arrest for violent crime (OR 3.24, 95% CI 1.34-7.78) after adjustment. Subjects in the self-inflicted firearm injury group were less likely than MVC controls to have a history involving both non-drug-related (OR 0.21, 95% CI 0.09-0.45) and drug-related felonies (0.22, 95% CI 0.11-0.45) but were more likely to have been arrested on firearms-related charges (OR 3.06, 95% CI 1.01-9.26). We found no significant differences between the unintentional firearm injury group and MVC controls in any of our models after adjusting for age, gender, and race.

DISCUSSION

We found significant differences in prior ten-year arrest history between groups defined by intent-specific firearm injury and unintentional MVC passenger injury controls. In additional to identifying distinct patterns of arrest, we found strong associations between intent-specific firearm injury and prior arrest on drug-related charges, felony charges, firearm-related charges, and for violent crime.

Our finding that assault-related firearm injury subjects were more likely to have arrest histories involving drug-related felonies and violent crimes supports the well-documented interrelationship between assault-related firearm violence and gang violence.(62,69,84) The assault-related firearm injury group had the greatest proportion of subjects with a criminal record, and the highest median number of arrests in the ten years prior to injury. This group had relatively frequent contact with the police, suggesting potential points of intervention that address both perpetrators and potential victims.

The lower odds of felony arrest history among subjects with self-inflicted firearm injuries relative to controls could be explained in several ways. It is possible that subjects who shot themselves were less likely to be arrested for a felony than subjects who were injured as passengers in motor vehicle accidents. It is also possible that, due to background checks, individuals with felony records were subsequently less able to purchase firearms and therefore had less access to firearms, which would be in keeping with prior research.(85,86) This may also explain why subjects with self-inflicted firearm injuries were more likely than controls to have a firearm-related arrest – while having a felony record would make it more difficult to purchase firearms, a history of firearm-related arrest would indicate confirmed access to firearms. As individuals with extensive criminal records are known to experience poor health and psychological distress later in life,(70) both key risk factors for suicide,(36) it is unsurprising that subjects with criminal records and confirmed access to firearms are at higher risk of self-inflicted firearm injury.

The strongest association identified pertained to the relation between arrest for violent crime and the legal intervention firearm injury group compared to controls in our gang involvement model. We identified similarities between legal intervention and assault-related firearm injury subjects, as both groups were more likely than controls to have been arrested for domestic violence and violent crimes. Unlike assault-related firearm injuries, we did not find an

association between legal intervention firearm injury and drug-related felony arrests. Although these injuries represent a small proportion of all firearm injuries, the strength of this association with our smallest case group (N=47) suggests the statistical power exists to further investigate this and other risk factors for this distinct sub-group.

As expected, we did not find any statistically significant differences in arrest history between subjects with unintentional firearm injuries and unintentional MVC passenger controls. This is reassuring, as unexpected differences in arrest history unintentional injury groups (firearm versus motor vehicle) could have been due to uncontrolled confounding.

There are some limitations to our study. Our analyses relied on arrest data for exposure categorization, and while arrest history reflects contact with the criminal justice system, it does not account for criminal acts or encounters with the police that do not lead to arrest. There are many circumstances and factors that may affect risk of firearm injury that are not captured in the arrest record, including gang affiliation and time spent in prison. As with any analyses based on the presence or absence of records in administrative data in Washington State there is likely to be some misclassification based on missing data. For clarity, we chose to limit our subject group to initial injuries during the study period; patterns of arrest and injury may differ when multiple firearm injuries are included.

To our knowledge, this is the first study to compare arrest histories of intent-specific firearm injury groups within the same population over the same time period. The multinomial logistic regression model choice allows for indirect comparison between case groups as well as between cases and controls. We were able to include long-term (10-year) exposure data from all of Washington State, not just Seattle, and the method of probabilistic linkage between our subjects and their exposure data accounted for data entry errors and the use of aliases that

would be missed under a deterministic method. Our study was also able to take advantage of Harborview Medical Center's role as the region's level 1 trauma center. Regional surveillance suggests that more than 85% of emergency department visits and 95% of hospitalizations for gunshot wounds in Seattle are seen at HMC.

This study identified differences and commonalities in arrest histories between subjects with intent-specific forms of firearm injury. We also demonstrated the feasibility and value of linking data from law enforcement and public health agencies. These initial insights can be used to develop future research and interventions involving both law enforcement and public health agencies, considering contacts with law enforcement as opportunities for intervention. Such targeted interventions have the potential to reduce both the criminal and medical burden of gun violence.

TABLES AND FIGURES

Table 2.1. Select subject characteristics by injury mechanism and intent, ages 21+, 2005-2014 in Seattle, WA

	Firearm injuries				Unintentional motor vehicle passenger injuries
	Assault-related	Self-inflicted	Unintentional	Legal Intervention	
	N=691 (%)	N=402 (%)	N=71 (%)	N=47 (%)	N=522 (%)
Male	614 (89.11)	355 (88.75)	65 (91.55)	44 (100)	220 (42.15)
Died	188 (27.29)	361 (90.25)	4 (5.63)	21 (44.68)	48 (9.20)
Died in hospital	64 (34.04)	25 (6.93)	0 -	9 (42.86)	17 (35.42)
Died at scene*	124 (65.96)	336 (93.07)	4 (100)	12 (57.14)	31 (64.58)
Age at Injury					
21-34	480 (69.46)	104 (25.87)	42 (59.15)	19 (40.43)	235 (45.02)
35-64	203 (29.38)	207 (51.49)	24 (33.80)	28 (59.57)	199 (38.12)
65+	8 (1.16)	91 (22.64)	5 (7.04)	0 -	88 (16.86)
Hispanic	73 (10.56)	15 (3.73)	8 (11.27)	2 (4.26)	66 (12.64)
Race					
White	156 (22.58)	336 (83.58)	39 (54.93)	30 (63.83)	248 (47.51)
African American	352 (50.94)	23 (5.72)	17 (23.94)	11 (23.40)	115 (22.03)
Asian Amer./Pac. Isl.	78 (11.29)	23 (5.72)	3 (4.23)	1 (2.13)	50 (9.58)
Native American	13 (1.88)	6 (1.49)	2 (2.82)	1 (2.13)	6 (1.15)
Other/Unknown	92 (13.31)	14 (3.48)	10 (14.08)	4 (8.51)	103 (19.73)
Insurance Category					
Insured	192 (27.79)	34 (8.46)	34 (47.89)	10 (21.28)	251 (48.08)
Self-pay	140 (20.26)	9 (2.24)	10 (14.08)	8 (17.02)	67 (12.84)
Medicaid/unbilled	203 (29.38)	16 (3.98)	18 (25.35)	13 (27.66)	138 (26.44)
Missing	156 (22.58)	343 (85.32)	9 (12.68)	16 (34.04)	66 (12.64)
Injury Severity Score◊					
<9	229 (33.14)	6 (1.49)	43 (60.56)	9 (19.15)	194 (37.16)
9-15	145 (20.98)	6 (1.49)	16 (22.54)	4 (8.51)	139 (26.63)
16-24	53 (7.67)	9 (2.24)	3 (4.23)	4 (8.51)	67 (12.84)
25+^	264 (38.21)	381 (94.78)	9 (12.68)	30 (63.83)	118 (22.16)

*"Died at scene" refers to fatal injuries in the field, which did not have a record of medical care and were identified based only on death records.

◊ May not sum to total due to missingness

^ Includes all subjects who died at scene

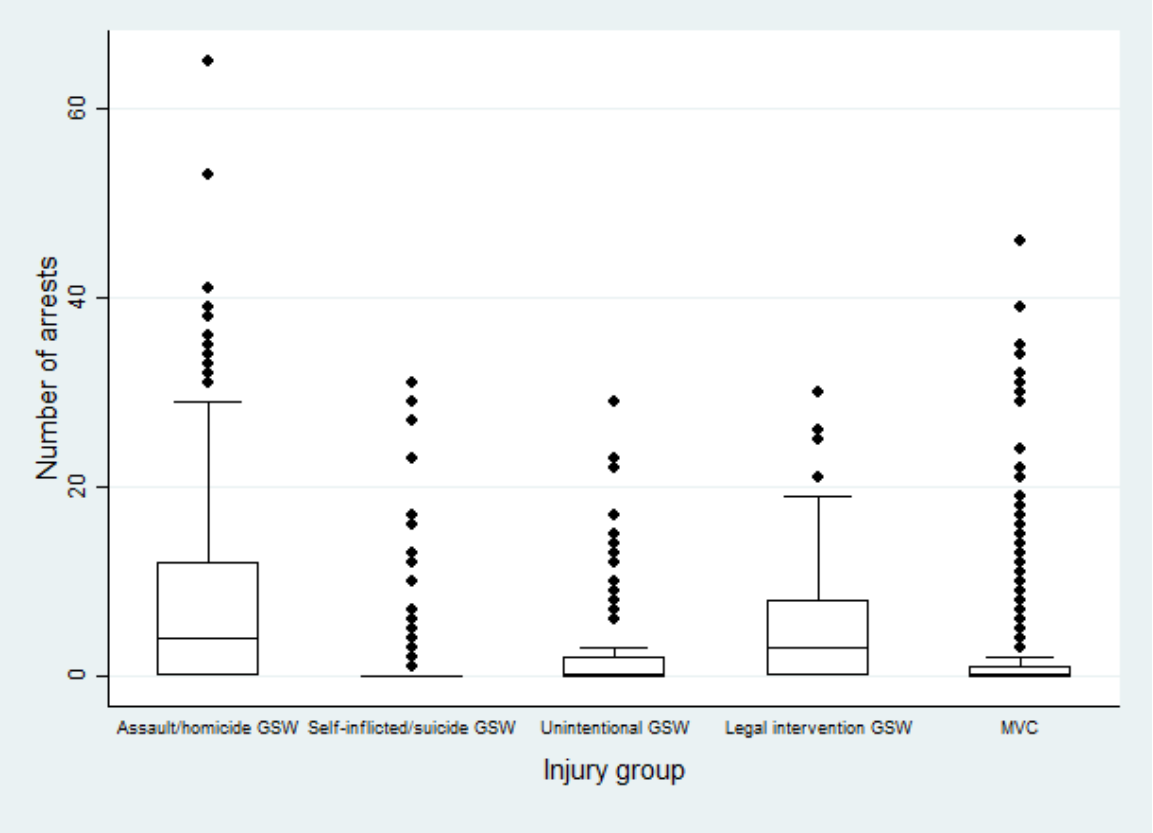
Table 2.2. Odds ratios of intent-specific firearm injury per category of arrest history, adjusted for age, gender, and race

Model	Exposure	Firearm injuries							
		Assault-related		Self-inflicted		Unintentional		Legal Intervention	
		OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
"Flagged" arrest models	No firearm arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
	Has firearm arrest record	3.37	(1.63-6.96)	1.20	(0.43-3.36)	1.71	(0.49-5.90)	1.93	(0.48-7.72)
	No DUI arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
	DUI arrest record	1.12	(0.68-1.83)	0.79	(0.43-1.47)	0.98	(0.40-2.40)	0.18	(0.02-1.39)
	No drug arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
	Drug arrest record	2.54	(1.79-3.60)	0.38	(0.22-0.66)	1.15	(0.59-2.24)	2.03	(0.99-4.19)
	No domestic violence record^	1.00	-	1.00	-	1.00	-	1.00	-
	Domestic violence record	1.81	(1.24-2.64)	0.78	(0.46-1.33)	0.62	(0.26-1.46)	2.28	(1.08-4.83)
Criminal severity Model	No arrest record	1.00	-	1.00	-	1.00	-	1.00	-
	Misdemeanor arrest record only	1.32	(0.87-2.00)	0.86	(0.54-1.36)	0.76	(0.35-1.66)	0.62	(0.17-2.26)
	Felony arrest record	2.70	(1.95-3.75)	0.33	(0.20-0.54)	0.82	(0.44-1.56)	3.57	(1.73-7.35)
Criminal violence Model	No violent arrest record	1.00	-	1.00	-	1.00	-	1.00	-
	Nonviolent arrest record only	1.66	(1.17-2.33)	0.50	(0.33-0.77)	0.66	(0.34-1.29)	1.17	(0.49-2.79)
	Violent arrest record	3.07	(2.11-4.45)	0.62	(0.37-1.04)	1.02	(0.50-2.09)	4.64	(2.13-10.11)
Gang involvement model	No arrest record	1.00	-	1.00	-	1.00	-	1.00	-
	Non-drug misdemeanor arrest only	1.14	(0.72-1.80)	0.82	(0.49-1.36)	0.70	(0.30-1.66)	0.47	(0.12-1.85)
	Drug-related misdemeanor arrest	1.09	(0.39-3.06)	0.26	(0.05-1.38)	0.46	(0.05-4.09)	inf	-
	Non-drug felony arrest record	1.28	(0.76-2.15)	0.21	(0.09-0.45)	0.37	(0.12-1.17)	1.91	(0.67-5.44)
	Drug-related felony arrest record	2.26	(1.44-3.54)	0.22	(0.11-0.45)	0.76	(0.31-1.84)	1.73	(0.63-4.76)
	No violent arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
	Violent arrest record	1.74	(1.13-2.67)	1.63	(0.87-3.05)	1.63	(0.70-3.83)	3.24	(1.34-7.78)
	No firearm arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
	Firearm arrest record	2.01	(0.94-4.30)	3.06	(1.01-9.26)	1.81	(0.48-6.81)	0.97	(0.23-4.01)

All ORs were obtained from multinomial logistic regression models in which the unintentional MVC passenger injury served as the control group

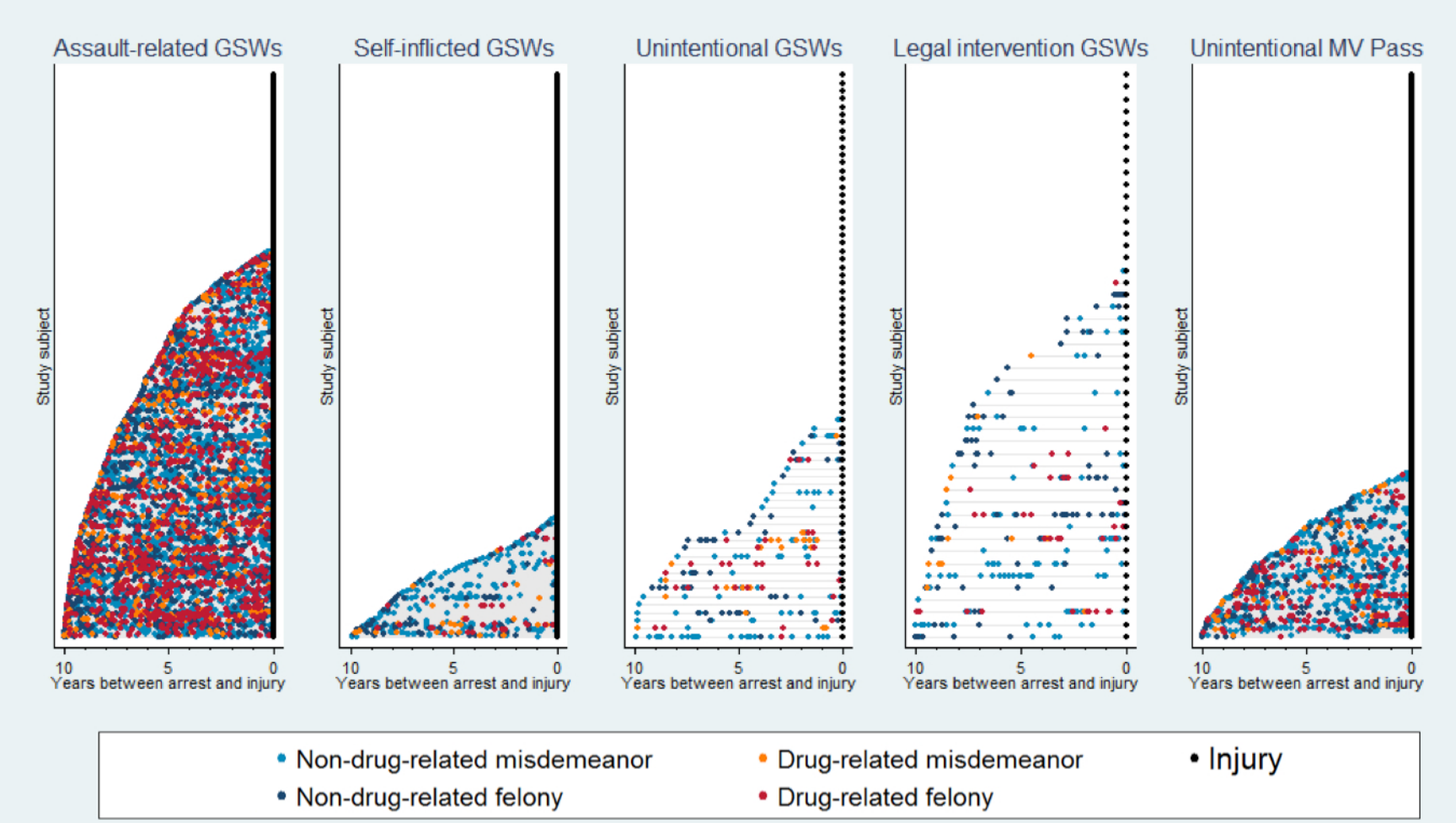
^ Includes those with other types of arrest

FIGURE 2.1. NUMBER OF ARRESTS IN 10 YEARS PRIOR TO INJURY, BY INJURY GROUP



The median number of arrests and interquartile range for each injury group are 9 (4-16) for assault-related firearm injury subjects, 2 (1-4) for self-inflicted firearm injury subjects, 6 (2-13) for unintentional firearm injury subjects, 5 (3-11) for legal intervention firearm injury subjects, and 4.5 (2-9) for unintentional MVC passenger injury subjects.

FIGURE 2.2. TIMELINE OF ARRESTS PRIOR TO INJURY, BY ARREST AND INJURY TYPE



Median time between most recent arrest and injury (in days) for each injury group is 261 (interquartile range (IQR) 93-681) for assault-related firearm injury subjects, 736 (IQR 147-1608) for self-inflicted firearm injury subjects, 425 (IQR 53-1044) for unintentional firearm injury subjects, 183 (IQR 64-1151) for legal intervention firearm injury subjects, and 537.5 (IQR 186-1115) for unintentional MVC passenger injury subjects.

Chapter 3: Prior arrest, substance use, or mental disorder diagnosis and risk of intent-specific firearm injury: A case-control study

ABSTRACT

Introduction: Substance use, mental disorder, and criminality are associated with increased firearm injury risk. As these factors are interrelated, examining them together can clarify their associations with assault-related, self-inflicted, unintentional, and legal intervention firearm injuries and inform targeted interventions.

Methods: Using a case-control study, we compared two-year diagnosis and arrest histories of intent-specific firearm injury patients (cases) to unintentionally injured motor vehicle collision (MVC) passengers (controls). We probabilistically linked 2010-2014 fatal and non-fatal firearm and MVC injuries occurring in Seattle or to Seattle residents to statewide hospitalization and arrest records. Multinomial logistic regression was used to compare odds of prior arrest, substance use, and mental disorder diagnosis among intent-specific firearm injury cases relative to controls, adjusting for age, race, and gender.

Results: We identified 763 firearm injury cases and 335 controls. Unintentional and self-inflicted firearm injury cases did not differ significantly from controls in arrest history. Assault-related firearm injury cases were more likely than controls to have a prior felony record but were not significantly more likely to have any prior substance use or mental disorder diagnoses. Legal intervention firearm injury cases were more likely than controls to have had a prior felony arrest (OR 7.72, 95% CI 2.63-20.97), or diagnosis involving alcohol use (OR 4.06, 95% CI 1.04-15.84), cannabis use (OR 11.00, 95% CI 1.01-119.36), depression (OR 7.22, 95% CI 1.89-

27.67), psychosis (OR 6.99, 95% CI 1.35-36.24), or conduct disorder (OR 22.01, 95% CI 1.44-335.93).

Conclusions: Subjects with different intent-specific firearm injuries have distinct patterns of prior substance use, mental disorder, and arrest. Many of these injuries occurred after a series of encounters with institutions that are meant to help individuals during crises but can fail to provide long-term solutions.

INTRODUCTION

The burden of firearm injury in the US involves more than interpersonal assault. One in five non-fatal firearm injuries are unintentional, and 22,018/36,252 (60%) of firearm deaths in 2015 were suicides.(1) While comparatively rare, rates of legal intervention firearm injuries have increased more than 10% over the past decade.(1)

Firearm injuries of different intent share certain risk factors. Prior arrest is associated with increased risk of sustaining firearm assault-related(67) and unintentional firearm injuries(67) as well as firearm homicide.(87) Studies of adolescents suggest that juvenile delinquency is associated with increased risk of sustaining firearm injury, including both assault and self-inflicted injuries,(88) and suicidal teens may have higher levels of involvement with the criminal justice system.(89) Substance use and mental disorder are risk factors for both assault-related(48,72,90,91) and self-inflicted(4,36,75,92,93) firearm injuries. Substance use and mental disorders are also contributing factors to legal intervention injuries (involving firearms and otherwise)(11,94,95) as police officers become *de facto* first responders to individuals in crisis.(11,14,15) Disruptive, impulsive, and conduct-related mental disorders are associated with increased risk of interpersonal violence(96,97) and firearm suicide,(98) and potentially associated with legal intervention firearm injuries.(99)

In addition to being shared risk factors for several intent-specific forms of firearm injury, substance use, mental disorder, and arrest are themselves interrelated. Substance use is associated with increased risk of arrest.(100,101) Individuals with severe mental disorders have high rates of arrest,(94,102) and mental disorders and substance use are frequently comorbid.(103–107) Associations between arrest and risk of intent-specific firearm injury may be influenced by substance use or mental disorders. Investigating arrest history, substance use,

and mental disorders together will help clarify how they each contribute to the risk of specific firearm injuries of different intent.

Our goal in this study was to generate an integrated picture of documented prior contacts with the criminal justice and medical systems for firearm injury patients in Seattle, including fatal and non-fatal injuries of all intents. By investigating the two years prior to injury for records of arrests and diagnoses of substance use, depression, psychoses, and conduct disorders, we sought to understand how patterns of these diagnoses and arrest history may serve as risk markers distinguishing intent-specific forms of firearm injury.

METHODS

Study design and population

We chose a case-control study design, as our goal was to distinguish risk markers for intent-specific forms of firearm injury and use a non-firearm injury control group for context. Firearm injuries were divided into four intent-specific case groups: assault-related (including homicide), self-inflicted (including suicide), unintentional, and legal intervention, excluding injuries with undetermined intent. A population-based control group was infeasible, as it would have required accessing hospital and arrest records for a random sample of Seattle residents (or those whose injury would have occurred in Seattle if they had sustained one). Instead, we chose a hospital-based control group of passengers (not drivers) injured in unintentional motor vehicle collisions. This type of injury is unlikely to be the result of the actions of the injured person, and risk of injury should not be heavily influenced by the injured individual's history of substance use, mental disorder, or arrest.

To ensure cases and controls were drawn from the same underlying population, the study was restricted to injuries occurring in Seattle or to Seattle residents, based on injury and residence location ZIP codes (981xx), respectively. The study was limited to the first firearm or MVC passenger injury sustained by an individual between January 2010 and December 2014. We excluded MVC injuries sustained by drivers and injuries where the location of the individual in the car was unrecorded. Subjects who sustained both a firearm and MVC passenger injury were included as firearm injury cases. The exposure period was limited to two years prior to injury, as identifiers common to all data sources for linking purposes were not available prior to 2008. As no arrest records were available for persons younger than 11 years, we limited our study population to persons 13 years of age or older at the time of injury to ensure equal exposure time for all subjects across data sources.

Data sources and subject identification

Firearm injury cases and MVC passenger injury controls were identified from the Harborview Medical Center (HMC) trauma registry and Washington State death records using the Centers for Disease Control and Prevention (CDC) recommended framework(108) for International Classification of Diseases (ICD-9) and ICD-10 external cause of injury codes (Supp Table 3.1). HMC is the Pacific Northwest region's Level 1 trauma center and routinely provides specialized care to injured patients from several states. Regional surveillance suggests that about 85% of emergency department (ED) visits and 95% of firearm injury hospitalizations in Seattle occur at HMC.

Data on diagnoses from prior hospitalizations were abstracted from the Comprehensive Hospital Abstract Reporting System (CHARS) maintained by the Washington State Department of Health.(109) CHARS contains records of inpatient treatment and observation stays in all state-licensed acute care, long-term, and cancer specialty hospitals in Washington State, including

psychiatric units. Data on arrests were abstracted from the Washington State Identification System (WASIS) criminal history database maintained by the Washington State Patrol.(82) WASIS aggregates arrest data from local law enforcement agencies across Washington. A probabilistic algorithm was used to identify duplicate records and link subjects to WASIS and CHARS records 2008-2014 (see Appendix for details). Study procedures were approved by the University of Washington and Washington State Institutional Review Boards.

Exposure variables

Substance use and mental disorder diagnoses in the two years prior to the index injury were identified based on ICD-9 diagnosis codes from hospitalizations, excluding hospitalizations less than 24 hours prior to injury to ensure exposures predated injury (Supp Table 3.2). Each hospitalization could have up to 25 diagnoses in the database. Substance use disorder included diagnoses related to alcohol use, cannabis use, and use of other drugs. Mental disorder included diagnoses for ICD-9 codes 290.xx-319.xx, excluding substance use codes 304.xx-305.xx. Specific mental disorder subcategories of interest to this study were (1) depression/mood disorders, (2) psychoses, and (3) disruptive/impulse-control/conduct disorders. Diagnoses were summarized into six binary variables: (1) alcohol, (2) cannabis, (3) other drug use, (4) psychoses, (5) depression/mood disorder, and (6) impulse-control/conduct disorder if any hospitalization in the previous two years included a ICD-9 diagnosis code for that disorder.

Arrests in the two years prior to injury were categorized by Revised Code of Washington charges (Supp Table 3.3), excluding arrests occurring in the 48 hours prior to injury to avoid including any incidents that led to both arrest and injury. We categorized arrest history based on severity of charges (misdemeanor or felony) into a 3-level ordinal variable: “no arrest history,” “misdemeanor arrests only,” and “felony arrests.”

Statistical analysis

Multinomial logistic regression was used to estimate associations between sustaining an intent-specific firearm injury (compared to an unintentional motor vehicle injury as a passenger) and odds of prior arrest, SUD, or mental disorder diagnosis. We first modeled each exposure separately (Supp. Table 3.4) and then adjusted for a minimum set of confounders including age, gender, and race. Our final multivariable models included both diagnoses and arrest history. Presented ORs should be interpreted as conditional ORs, where the OR represents the relative odds of having the exposure for a certain case group, conditional on being in that case group or being in the MVC passenger control group. For example, the OR for prior alcohol use diagnosis and self-inflicted firearm injury is the relative odds of an alcohol use diagnosis for the self-inflicted group conditional on having either a self-inflicted firearm or MVC passenger injury. Direct comparisons between firearm injury groups are available (Supp Tables 3.5 and 3.6). Probabilistic linkage was done using The Link King (Camelot Consulting, Olympia, WA). Statistical analyses were done using Stata 14 (StataCorp LP, College Station, TX).

RESULTS

Characteristics of the study population

We identified 763 firearm and 335 MVC passenger injuries that met our inclusion criteria during the study period (Table 3.1). We excluded 16 “undetermined” intent injuries (1%). Three subjects sustained both firearm and MVC passenger injuries and were included as firearm injury cases. A majority of firearm injuries were assault-related (58.1%), followed by self-inflicted (28.6%), unintentional (9.3%), and legal intervention (4.1%). A majority of firearm injuries were sustained by males but intent groups varied in age, race, insurance status, and injury severity.

Patterns of prior arrest and hospitalization among injury groups

Prior arrest was more common than hospitalization (for any cause) for all groups except self-inflicted injuries (Table 3.1). Arrests were most common in the assault-related (48.5%) and legal intervention groups (48.4%). Prior hospitalization was most common in the self-inflicted group (25.2%). No one with an unintentional firearm injury was hospitalized in the two years prior to injury.

Among subjects with prior arrests, assault-related and unintentional firearm injury subjects had the highest median number of arrests (Supp Fig. 3.1a). A majority of arrested subjects in the assault-related, unintentional, and legal intervention firearm injury groups had a felony arrest record (Table 3.1). Among subjects who had been both arrested and hospitalized, legal intervention injury subjects had the greatest mean ratio of hospitalizations to arrests (4.6 hospitalizations per arrest). Timelines of 2-year hospitalization and arrest history for a random subsample of 25 subjects in each injury group are shown in Fig. 3.1, with each subject's timeline as a separate row to highlight the varying proportion of subject in each group hospitalized or arrested, and relative frequency of each type of hospitalization or arrest.

Among subjects with a prior hospitalization, the legal intervention group had the greatest median number of hospitalizations (Supp Fig. 3.1b), briefest period between last hospitalization and injury (Table 3.1), and greatest mean number of hospital facilities visited. A majority of previously hospitalized subjects in the legal intervention group had been diagnosed with comorbid substance use and mental disorders (66.7%). A majority of previously hospitalized subjects in the self-inflicted group had been diagnosed with a mental disorder (63.6%) (Table 3.1).

Prior arrest

Assault-related firearm injury cases were more likely than controls to have had a prior felony arrest (OR 4.4, 95% CI 2.4-8.1) (Table 3.2). Legal intervention firearm injury cases were almost 8 times more likely to have a felony record than controls (OR 7.4, 95% CI 2.6-21.0). Self-inflicted firearm injury cases did not differ significantly from controls in their arrest histories.

Prior substance use diagnoses

Legal intervention cases were more likely to have had a diagnosis related to alcohol use (OR 4.1, 95% CI 1.0-15.8) or cannabis use (OR 11.0, 95% CI 1.0-119.4) than controls, (Table 3.2). Subjects in the assault-related and self-inflicted firearm injury groups did not have significantly different substance-related diagnosis histories from controls. Prior diagnoses involving substances other than alcohol or cannabis were not significantly different between any of the firearm injury case groups and controls.

Prior mental disorder diagnoses

We found greater odds of depression/mood disorder diagnosis in the self-inflicted firearm injury group (OR 2.9, 95% CI 1.2-6.7) and the legal intervention firearm injury group (OR 7.2, 95% CI 1.9-27.7) compared to controls (Table 3.2). Legal intervention firearm injury subjects were more likely than controls to have prior diagnoses for psychoses (OR 7.0, 95% CI 1.4-36.2) or disruptive/impulsive/conducted-related disorders (OR 22.0, 95% CI 1.4-335.9). Assault-related firearm injury subjects did not significantly differ from controls in their prior mental disorder diagnoses.

Prior arrest and substance use or mental disorder diagnosis

The greater odds of a felony arrest history for subjects with either an assault-related or legal intervention firearm injury was consistent when prior diagnoses and arrests were modeled together (Table 3.3). Legal intervention firearm injury subjects were still more likely than controls

to have had a cannabis-related diagnosis (OR 12.9, 95% CI 1.1-148.7) when arrest history was included in the model. The greater odds of an alcohol-related diagnosis in the legal intervention firearm injury group remained strong but imprecise (OR 3.7, 95% CI 0.9-15.3). Subjects with self-inflicted firearm injuries were still more likely than controls to have had a depression diagnosis (OR 2.9, 95% CI 1.2-6.9). Subjects with legal intervention firearm injuries were still more likely than controls to have had a prior diagnosis of depression (OR 7.1, 95% CI 1.8-28.3) or psychosis (OR 6.8, 95% CI 1.3-36.0) and their greater odds of conduct-related diagnoses remained strong but imprecise (due to small sample size) (OR 16.6, 95% CI 0.9-295.8) when arrest and hospitalization history were modeled together.

DISCUSSION

We identified significant differences in prior two-year history of arrest, substance use, and mental disorder diagnoses among intent-specific firearm injury groups and injured motor vehicle passengers. Individuals with an assault-related or legal intervention firearm injuries were more likely than controls to have a prior felony arrest, regardless of prior substance use or mental disorder diagnoses. Legal intervention firearm injury was associated with prior diagnoses related to cannabis use, psychoses, conduct disorder, and depression after accounting for arrest history.

Individuals with legal intervention firearm injuries stood out from other subjects due to their associations with multiple substance use and mental disorder diagnoses and increased contact with both the medical and criminal justice systems. The strongest, albeit imprecise, association was with impulsivity and conduct-related disorders. These results are in keeping with findings from the Seattle Police Department,(110) other law enforcement agencies(111) and researchers

in the United States(95,112) who have also identified an increased risk of legal intervention injury for individuals with a mental disorder or under the influence of drugs or alcohol.

Our study has several limitations. Arrest and hospitalization records only document contacts with the criminal justice and medical systems that reach a certain threshold. Arrests are not representative of all encounters with law enforcement, and WASIS does not capture criminal behavior or contacts with law enforcement that do not lead to arrest. CHARS only contains records of hospitalization. Neither system includes records from outside Washington State. Individuals whose contact with law enforcement or health professionals was not documented via arrest or hospital diagnosis were treated as "unexposed" in our models, which could have led to an underestimation of the strength of associations between our exposures and intent-specific injury risk. As an example, we did not identify significant differences in substance use disorder diagnoses between assault-related and self-inflicted firearm injury groups and MVC passenger controls; although substance use is a known risk factor for both types of injuries.(72,90,91) This is likely because many substance use issues increase risk of injury but do not involve a diagnosis during hospitalization. Our two-year time frame for exposure may have been overly brief, as individuals arrested and convicted for serious offenses may have been in custody and not at risk of a firearm injury. Our study population was small and hospitalization was a rare event, which limited the statistical power, including our ability to investigate how racial disparities in the criminal justice system and in access to healthcare may impact risk of firearm injury. We were unable to increase our statistical power by lengthening the study period or the exposure window to 5 or 10 years pre-injury because we were limited by the availability of identifiable data.

Our study had several strengths. By combining data from the regional trauma center and statewide death certificates, we were able to include nearly every individual shot in Seattle in

our case group, including those who only received care for their firearm injury in the ED and those who died before medical treatment could be provided. HMC treats the overwhelming majority of all firearm injuries in Seattle, reducing concern that a small sample may be unrepresentative of a larger population. We used exposure data from the whole of Washington State and probabilistic methods to link across data sources, reducing potential misclassification. By disaggregating substance use and mental disorders into narrower diagnostic categories, we were able to identify more specific, and therefore useful, risk markers. By using administrative data, our methods are replicable elsewhere, which will clarify the generalizability of our results.

The patterns of prior arrest and diagnoses identified in this study can inform intent-specific firearm injury prevention programs. The relative greater frequency of arrests compared to hospitalizations in the firearm assault injury group suggests most opportunities for intervention in this group occur while individuals are in custody, not when they are in the hospital. Screening instruments for mental disorders or risk of firearm violence, like the SaFETy Score,(113) can be validated and potentially adapted for use in multiple settings, including by law enforcement. As with any screening program, treatment must be made available after screening, with continuity of care during hospitalization, incarceration, and in the community. Coordination between law enforcement and mental health services, including de-escalation training for officers tasked as first responders and specialized crisis response teams with decision-making authority given to qualified mental health professional may lead to better outcomes in confrontations between police and individuals in crisis. Police departments, including Seattle's, have begun to make some of these changes.(94,114,115) When firearm injury research is potentially applicable to both law enforcement and public health practice, it should draw on both law enforcement and public health data.

Conclusions

To our knowledge, this is one of the first studies to identify unique and shared risk markers in arrest and hospital records for all intent-specific firearm injuries. Our results quantify how differing patterns of prior arrest, substance use, and mental disorders all contribute to risk of intent-specific firearm injury. Many of these injuries occurred after a series of encounters with institutions that are meant to help individuals during crises but can fail to provide long-term solutions.

TABLES AND FIGURES

Table 3.1. Select subject characteristics by injury mechanism and intent, 2010-2014, Seattle, WA

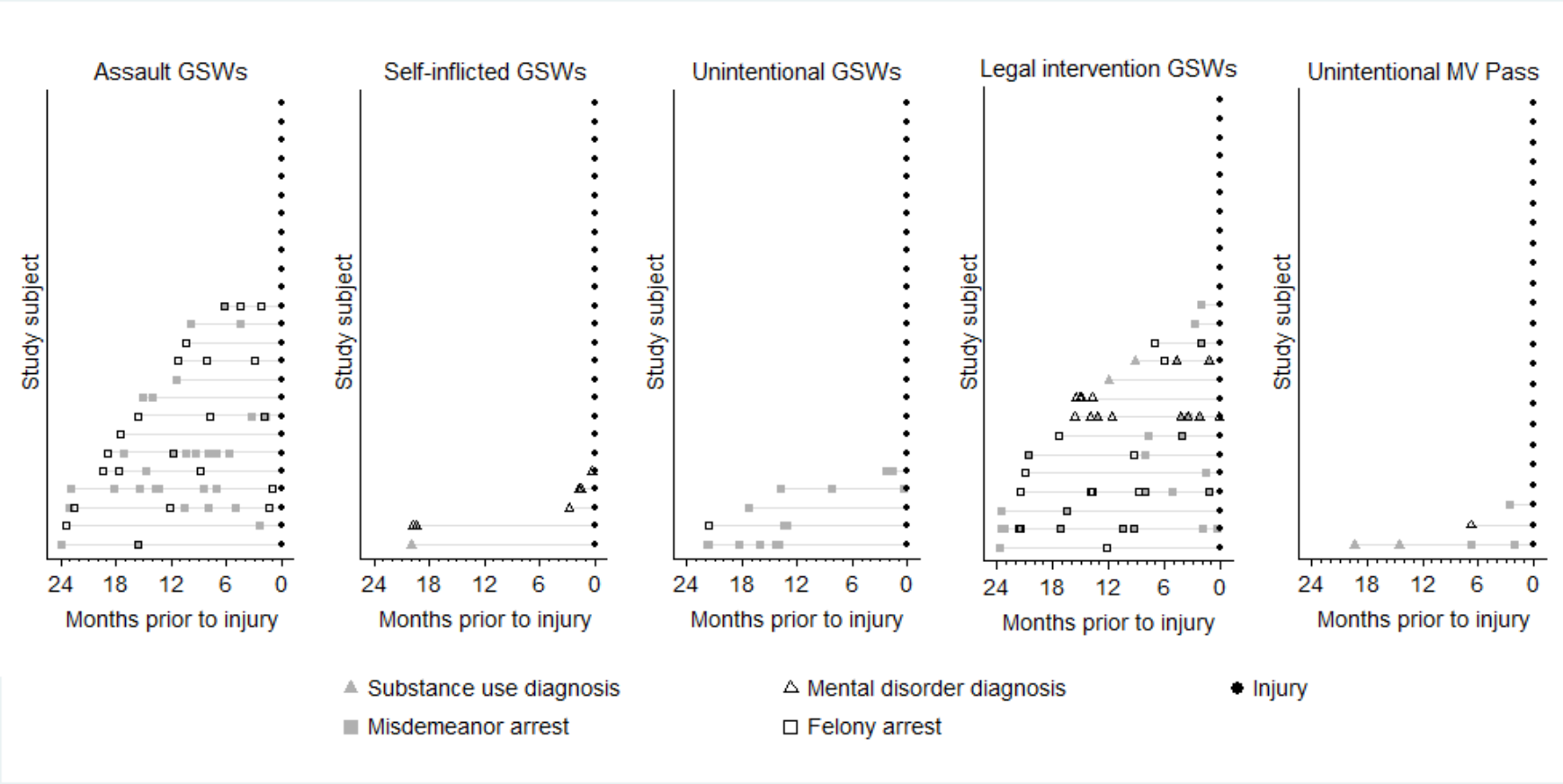
	Firearm injuries				Unintentional motor vehicle passenger injuries
	Assault-related	Self-inflicted	Unintentional	Legal Intervention	
	N=443 (%)	N=218 (%)	N=71 (%)	N=31 (%)	N=335 (%)
Male	386 (87.13)	189 (86.70)	63 (88.73)	31 (100)	144 (42.99)
Died	103 (23.25)	195 (89.45)	3 (4.23)	16 (51.61)	25 (7.46)
Died in hospital	38 (36.89)	14 (7.18)	0 -	7 (43.75)	9 (36.00)
Died at scene[1]	65 (63.11)	181 (92.82)	3 (100)	9 (56.25)	16 (64.00)
Age at Injury					
13-20	110 (24.83)	6 (2.75)	26 (36.62)	3 (9.68)	76 (22.69)
21-39	256 (57.79)	73 (33.49)	29 (40.85)	16 (51.61)	128 (38.21)
40-59	70 (15.80)	68 (31.19)	11 (15.49)	11 (35.48)	64 (19.10)
60+	7 (1.58)	71 (32.57)	5 (7.04)	1 (3.23)	67 (20.00)
Race					
White	84 (18.96)	178 (81.65)	31 (43.66)	19 (61.29)	146 (43.58)
African American	247 (55.76)	14 (6.42)	22 (30.99)	6 (19.35)	68 (20.30)
Other/Unknown	112 (25.28)	26 (11.93)	18 (25.35)	6 (19.35)	121 (36.12)
Insurance Category					
Insured	141 (31.83)	22 (10.09)	34 (47.89)	5 (16.13)	182 (54.33)
Self-pay	19 (4.29)	1 (0.46)	2 (2.82)	1 (3.23)	20 (5.97)
Medicaid/unbilled	179 (40.41)	9 (4.13)	25 (35.21)	12 (38.71)	96 (28.66)
Missing	104 (23.48)	186 (85.32)	10 (14.08)	13 (41.94)	37 (11.04)
Injury Severity Score[2]					
<9	179 (40.41)	2 (0.92)	47 (66.20)	3 (9.68)	141 (42.09)
9-15	92 (20.77)	3 (1.38)	13 (18.31)	2 (6.45)	87 (25.97)
16-24	42 (9.48)	9 (4.13)	4 (5.63)	3 (9.68)	45 (13.43)
25+[3]	130 (29.35)	204 (93.58)	7 (9.86)	23 (74.19)	57 (17.01)
Arrests and hospitalizations in prior 2 years					
None	208 46.95	151 69.27	53 74.65	13 41.94	238 71.04
Hospitalization only[3]	20 4.51	48 22.02	0 -	3 9.68	44 13.13
Arrest only	197 44.47	12 5.50	18 25.35	12 38.71	41 12.24
Hospitalization[3] and arrest	18 4.06	7 3.21	0 -	3 9.68	12 3.58
Mean hospitalization:arrest ratio[5] (range)	0.74 (0.06-2.0)	1.36 (0.5-2.5)	n/a	4.56 (1.7-8.0)	1.54 (0.2-6.0)
Mean number of hospitals visited[6] (range)	1.26 (1-3)	1.36 (1-4)	n/a	2.5 (1-5)	1.18 (1-2)
Median days between last hospitalization and injury (IQR)[6]	364 (231-534)	221 (84-426)	n/a	55 (25-364)	273 (132-530)
Median days between last arrest and injury (IQR)[7]	151 (67-349)	134 (56-365)	142 (21-423)	126 (63-369)	243 (92-455)

Table 3.1. Cont'd

	Firearm injuries				Unintentional motor vehicle passenger injuries
	Assault-related	Self-inflicted	Unintentional	Legal Intervention	
	N=443	N=218	N=71	N=31	N=335
	N %	N %	N %	N %	N %
Prior diagnosis of[8]:					
Substance use (all)[6]	13 34.21	18 32.73	n/a	5 83.33	16 28.57
Alcohol use[6]	6 15.79	16 29.09	n/a	4 66.67	9 16.07
Cannabis use[6]	2 5.26	3 5.45	n/a	2 33.33	2 3.57
Other substance use[6]	9 23.68	6 10.91	n/a	3 50.00	15 26.79
Mental disorder (all)[6]	14 36.84	35 63.64	n/a	5 83.33	25 44.64
Depression/mood disorders[6]	7 18.42	19 35.55	n/a	4 66.67	15 26.79
Psychotic disorders[6]	6 15.79	4 7.27	n/a	3 50.00	6 10.71
Conduct disorders[6]	3 7.89	0 0.00	n/a	2 33.33	1 1.79
Comorbid substance use and mental disorder[6]	7 18.42	14 25.45	n/a	4 66.67	12 21.43
Prior arrest for[8]:					
Misdemeanor offenses[7]	185 86.05	18 94.74	16 88.89	14 93.33	47 88.68
Felony offenses[7]	127 59.07	5 26.32	9 50.00	9 60.00	15 28.30

1"Died at scene" refers to fatal injuries in the field, who did not have a record of medical care and were identified based only on death records.
2 May not sum to total due to missingness
3 Hospitalizations for any reason, not limited to diagnoses for substance use or mental disorder
4 Includes all subjects who died at scene
5 Among subjects with both hospitalization and arrest records
6 Among subjects with a hospitalization record
7 Among subjects with an arrest record
8 Categories not mutually exclusive; a single visit/arrest may involve multiple diagnoses/charges
IQR = interquartile range

FIGURE 3.1. TIMELINE OF ARRESTS, SUBSTANCE USE AND MENTAL DISORDER DIAGNOSES IN 2 YEARS PRIOR TO INJURY, BY INJURY INTENT AND MECHANISM



Timelines for a random sample of 25 study subjects per injury group. Each row represents a unique study subject, arranged from the subject with the earliest arrest/diagnosis (bottom) to subjects with no prior arrest/diagnoses at the top.

Table 3.2. Odds ratios for prior arrests or diagnoses by intent-specific firearm injury, adjusted for age, gender, and race

	Arrests and diagnoses in prior 2 years	Assault-related		Self-inflicted		Legal Intervention	
		OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Substance use	No alcohol-related diagnoses^	Ref		Ref		Ref	
	Alcohol-related diagnoses	0.64	(0.20, 2.03)	1.66	(0.63, 4.36)	4.06	(1.04, 15.84)
	No cannabis-related diagnoses^	Ref		Ref		Ref	
	Cannabis-related diagnoses	0.82	(0.08, 8.72)	2.12	(0.26, 17.33)	11.00	(1.01, 119.36)
	No other substance-related diagnoses^	Ref		Ref		Ref	
	Other substance-related diagnoses	0.58	(0.22, 1.49)	0.43	(0.14, 1.31)	2.07	(0.50, 8.55)
Mental disorder	No depression-related diagnoses^	Ref		Ref		Ref	
	Depression/mood-related diagnoses	0.82	(0.29, 2.33)	2.85	(1.20, 6.73)	7.22	(1.89, 27.67)
	No psychosis-related diagnoses^	Ref		Ref		Ref	
	Psychosis-related diagnoses	1.01	(0.28, 3.61)	1.03	(0.23, 4.58)	6.99	(1.35, 36.24)
	No impulse/conduct-related diagnoses^	Ref		Ref		Ref	
	Impulse/conduct-related diagnoses	1.35	(0.12, 14.61)	-	(0, ∞)	22.01	(1.44, 335.93)
Arrest	No arrest history	Ref		Ref		Ref	
	Misdemeanor arrests only	1.51	(0.94, 2.44)	0.61	(0.30, 1.25)	2.28	(0.79, 6.54)
	Felony arrests	4.41	(2.40, 8.10)	0.51	(0.17, 1.51)	7.42	(2.63, 20.97)

All ORs were obtained from multinomial logistic regression models in which the unintentional MVC passenger injury served as the control group. Unintentional firearm injury subjects were not included in analyses of prior diagnoses. In the analysis of prior arrests, unintentional firearm injury subjects were no more likely than controls to have a prior arrest for misdemeanors (OR 0.81, 95% CI 0.35-1.84) or felonies (OR 1.67, 95% CI 0.67-4.20).
^ includes those with other types of diagnoses

Table 3.3. Odds ratios for combined prior arrests and diagnoses by intent-specific firearm injury, adjusted for age, gender, and race

	Arrests and diagnoses in prior 2 years	Firearm injuries: Assault-related OR	(95% CI)	Self-inflicted OR	(95% CI)	Legal Intervention OR	(95% CI)
Substance use	No alcohol-related diagnoses^	Ref		Ref		Ref	
	Alcohol-related diagnoses	0.62	(0.19, 1.97)	1.92	(0.72, 5.11)	3.69	(0.89, 15.30)
	No history of arrest	Ref		Ref		Ref	
	Misdemeanor arrest history only	1.53	(0.94, 2.47)	0.56	(0.27, 1.16)	1.86	(0.63, 5.52)
	Felony arrest history	4.41	(2.40, 8.10)	0.51	(0.17, 1.50)	7.28	(2.57, 20.59)
	No cannabis-related diagnoses^	Ref		Ref		Ref	
	Cannabis-related diagnoses	0.87	(0.08, 9.35)	2.19	(0.25, 18.95)	12.87	(1.11, 148.68)
	No history of arrest	Ref		Ref		Ref	
	Misdemeanor arrest history only	1.51	(0.93, 2.44)	0.60	(0.30, 1.24)	2.23	(0.77, 6.52)
	Felony arrest history	4.41	(2.40, 8.11)	0.51	(0.17, 1.51)	7.71	(2.71, 21.94)
	No other substance-related diagnoses^	Ref		Ref		Ref	
	Other substance-related diagnoses	0.47	(0.18, 1.23)	0.44	(0.14, 1.35)	1.65	(0.39, 7.04)
	No history of arrest	Ref		Ref		Ref	
	Misdemeanor arrest history only	1.60	(0.98, 2.60)	0.64	(0.31, 1.33)	2.20	(0.75, 6.39)
	Felony arrest history	4.55	(2.46, 8.39)	0.52	(0.18, 1.56)	7.35	(2.60, 20.81)
Mental disorder	No depression-related diagnoses^	Ref		Ref		Ref	
	Depression/mood-related diagnoses	0.80	(0.28, 2.23)	2.94	(1.24, 6.93)	7.13	(1.80, 28.25)
	No history of arrest	Ref		Ref		Ref	
	Misdemeanor arrest history only	1.51	(0.94, 2.45)	0.59	(0.29, 1.21)	2.09	(0.72, 6.08)
	Felony arrest history	4.40	(2.40, 8.09)	0.51	(0.17, 1.52)	7.61	(2.68, 21.61)
	No psychosis-related diagnoses^	Ref		Ref		Ref	
	Psychosis-related diagnoses	0.96	(0.27, 3.47)	1.01	(0.22, 2.60)	6.82	(1.29, 36.00)
	No history of arrest	Ref		Ref		Ref	
	Misdemeanor arrest history only	1.51	(0.93, 2.45)	0.61	(0.30, 1.25)	2.12	(0.73, 6.19)
	Felony arrest history	4.41	(2.40, 8.10)	0.51	(0.17, 1.50)	7.51	(2.64, 21.33)
	No impulse/conduct-related diagnoses^	Ref		Ref		Ref	
	Impulse/conduct-related diagnoses	1.15	(0.10, 12.88)	-	$(0, \infty)$	16.61	(0.93, 295.76)
	No history of arrest	Ref		Ref		Ref	
	Misdemeanor arrest history only	1.51	(0.93, 2.44)	0.61	(0.30, 1.26)	2.03	(0.69, 5.95)
	Felony arrest history	4.40	(2.39, 8.08)	0.52	(0.18, 1.55)	6.70	(2.33, 19.30)

All ORs were obtained from multinomial logistic regression models in which the unintentional MVC passenger injury served as the control group

^ includes those with other types of diagnoses

Conclusion

In addition to the conclusions presented within each chapter, there are three overarching conclusions to this dissertation. First – intent groups do provide meaningful distinctions between different forms of firearm injury. Second – by comparing intent groups in a single study, we can identify both unique and common risk markers for these different forms of firearm injury. Three – linking data from a variety of sources, especially medical and legal administrative data sources, is feasible and valuable.

Relying on administrative data is a challenge for firearm injury researchers, but research based on administrative data is also directly translatable into interventions at the points of contact that generate said data. The addition of incident location to standard injury surveillance reports would streamline future research and intervention planning. The results of all three chapters point out missed opportunities for interventions. Place-based interventions should consider both where firearm injuries occur and where injured individuals reside, as these two locations may be geographically distinct and represent different (chronic and immediate) influences on risk of firearm injury. Interventions aimed at preventing firearm injury should take place where individuals at risk of injury are found. In the case of assault-related firearm injuries, this is likely to be in police custody. Regardless of location, interventions and screenings must include pathways to long-term treatment options and ensure continuity of services as individuals transition between law enforcement custody, medical supervision, and their neighborhood communities.

Stronger recommendations require replication of these findings in other populations, to determine generalizability. There is much more research to be done on legal intervention

firearm injuries and the role of impulse and conduct disorder on multiple types of injuries, in particular. There are complex relationships between mental health, injury, and race that are only hinted at in these three chapters, but need to be acknowledged and further investigated.

Methodologically, the choice of injured motor vehicle passengers as a control group is worth further study. As in any epidemiological study, results are relative, and extrapolating from a comparison between two groups of injured individuals to the underlying population depends on understanding how accurately, or inaccurately, MVT passengers represent the general population. Whenever possible, we chose a conservative approach to inclusions and exclusion criteria, defining cases and controls, and interpreting results.

While this dissertation presents a more integrated picture of firearm injuries in Seattle, it is by no means a complete picture. The next stage is twofold; collaborating with interested institutions to translate results into interventions and using more sophisticated methods to better address the complexities of intent-specific firearm injury risk to reduce the overall burden that these distinct forms of injury have on individuals and communities across the United States.

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Appendix

Data linkage process

Data from four separate sources were linked to create the analytic dataset for this study. Study subjects, based on ICD-9 codes, were identified in the Harborview (HMC) Trauma Registry and Washington State death records. These sources were linked in order to merge records of subjects who were treated at Harborview and subsequently died as a result of the same event (deduplication). During deduplication, subjects with multiple visits were also identified, and only the first record during the study period was retained. After establishing the study population, subjects were linked to arrest and hospitalization files from 2008-2014. Arrests and hospitalizations that occurred more than 730 days pre-injury or post-injury were excluded.

All three linkages were conducted using The Link King (www.the-link-king.com). The Link King integrates a deterministic algorithm with probabilistic protocols, and technical details and empirical evaluations of the software has been described elsewhere.(1-4) The Link King was chosen in part because it was developed using Washington State data from several administrative datasets maintained by Washington State agencies(3) and was likely to be particularly well suited to the data sources used in this study.

All linkages were established using subjects' first name, last name, middle initial, gender, birth date, and the last four digits of their social security number (SSN). When linking to arrest records, the Washington State Patrol unique identifier was used to cross-link subjects with multiple aliases. As an integrated deterministic/probabilistic program, The Link King requires a minimum of first name, last name, and either SSN or birth date in order to generate possible links. As our study population was small, we were able to use high level blocking based on the

Department of Alcohol and Substance Abuse (DASA)'s second expansion of modified SAMHSA criteria. A complete breakdown of these criteria are available in The Link King user manual.(2) Standard probabilistic weights recommended by SAMHSA were used, and all potential linkages were manually reviewed (average manual reviews per annual file = 93). Although not without error, manual review is the standard mechanism for resolving uncertain linkages.(5) A conservative approach to manual review was used, as any potential link with disagreement or missingness in two or more identifiers was discarded. The highest level of certainty (perfect match on all available identifiers) was found for >90% of all links. Since the number of links per annual data file was too small to estimate an overall Positive Predictive Value (PPV) for our data linkage procedure, we followed recommended protocols, which have been estimated to result in PPVs around 97%.(2,3)

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Supp Table 1.1. Intent categories defined by ICD-9 and ICD-10 code

	Assault	Self-inflicted	Unintentional	Legal intervention*
ICD-9 codes	E965.XX	E955.XX	E922.XX, 917.4	E970
ICD-10 codes	X93, X94, X95	X72, X73, X74	W32, W33, W34	Y35, Y36, Y89
Definition^	Injuries caused by one or more persons with the intent of causing harm, injury, or death to another person	Injuries with the intent to take one's own life or with the intent to harm oneself, including suicide, suicide attempt, and other intentional self-harm	Injuries not inflicted by deliberate means (i.e., not on purpose), regardless of whether the injury was inflicted by oneself or by another person	Injuries caused by police or other legal authorities (including security guards) during law enforcement activities

* All injuries categorized as legal intervention were confirmed by news reports and medical record review

^Based on Centers for Disease Control and Prevention (CDC) definitions for WISQARS Nonfatal Injuries, http://www.cdc.gov/ncipc/wisqars/nonfatal/definitions.htm

Supp Table 1.2. Neighborhood characteristics based on SNCS questions

Measure	Question	Scale
"Code of the streets"	Q22a: In this neighborhood, for young people to gain respect among their peers, they sometimes have to be willing to fight. To what extent would people in your neighborhood agree or disagree with that statement?	1 = Strongly disagree 2 = Disagree 3 = Agree 4 = Strongly agree
	Q22b: In this neighborhood, if a loved one is disrespected, people retaliate even if it means resorting to violence. To what extent would people in your neighborhood agree or disagree with that statement?	
	Q22c: In this neighborhood, young men who own guns are often looked up to and respected. To what extent would people in your neighborhood agree or disagree with that statement?	
	Q22e: In this neighborhood, parents teach their kids to fight back if they are insulted or threatened. To what extent would people in your neighborhood agree or disagree with that statement?	
	Q22f: In this neighborhood, young men often project a tough or violent image to avoid being threatened with violence. To what extent would people in your neighborhood agree or disagree with that statement?	
Negative opinion of police	Q16c: How effective would the following approach be in resolving major problems around your neighborhood: contacting the police?	1 = Highly effective 2 = Somewhat effective 3 = Not at all effective
	Q24b: It is rare for an innocent man to be wrongly accused and sent to jail.	1 = Strongly agree 2 = Agree 3 = Disagree 4= Strongly disagree
	Q25a: The police are doing a good job in dealing with problems that really concern people in this neighborhood.	
	Q25b: Racial profiling is a problem in this neighborhood.	1 = Strongly disagree 2 = Disagree 3 = Agree 4 = Strongly agree
	Q25c: In this neighborhood, police just hassle residents, rather than being helpful.	
Handgun ownership	Q65: Do you own a handgun, including any handgun you may keep at work or in an automobile, including those used for sport or protection on the job?	0 = No 1 = Yes
Fear of crime	Q52: How often do you worry or think about being physically attacked by a stranger in your neighborhood?	1 = Less than once a month 2 = Once a month 3 = About once a week 4 = Every day
	Q53: How about someone breaking into your home and stealing your property?	
	Q54: How safe do you think your neighborhood is from crime and criminals?	1 = Very safe 2 = Somewhat safe 3 = Somewhat unsafe 4 = Very unsafe

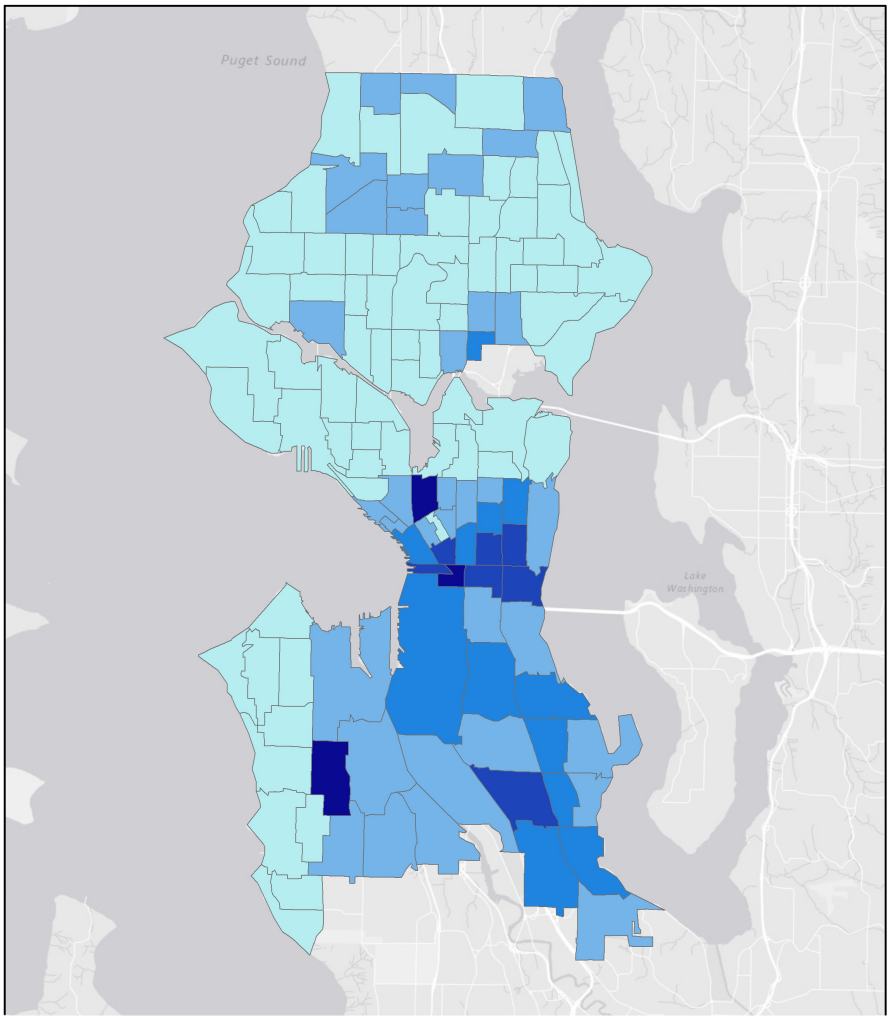
Supp Table 1.3. Pearson correlations between neighborhood characteristic quintiles

	Code of the streets	Fear of crime	Handgun ownership	Negative opinions of the police	Disadvantage index^
Code of the streets	1				
Fear of crime	0.55*	1			
Handgun ownership	0.03	-0.01	1		
Negative opinions of the police	0.59*	0.51*	-0.14	1	
Disadvantage index^	0.68*	0.54*	0.06	0.61*	1

*Statistically significant, p<0.001

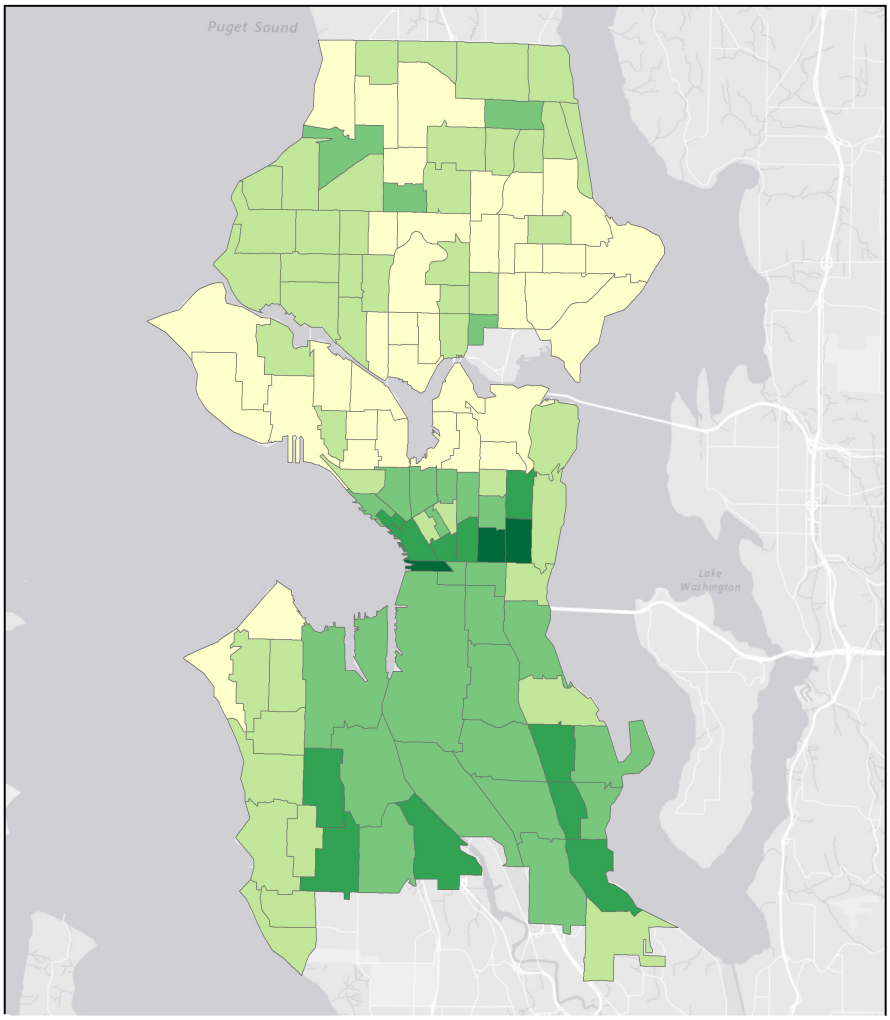
^ Includes % female-headed households, % below the poverty line, % receiving welfare, % unemployed, % African American, and % under 18 years of age.

SUPP FIGURE 1.1. DISADVANTAGE INDEX MAPPED TO SEATTLE CENSUS TRACTS



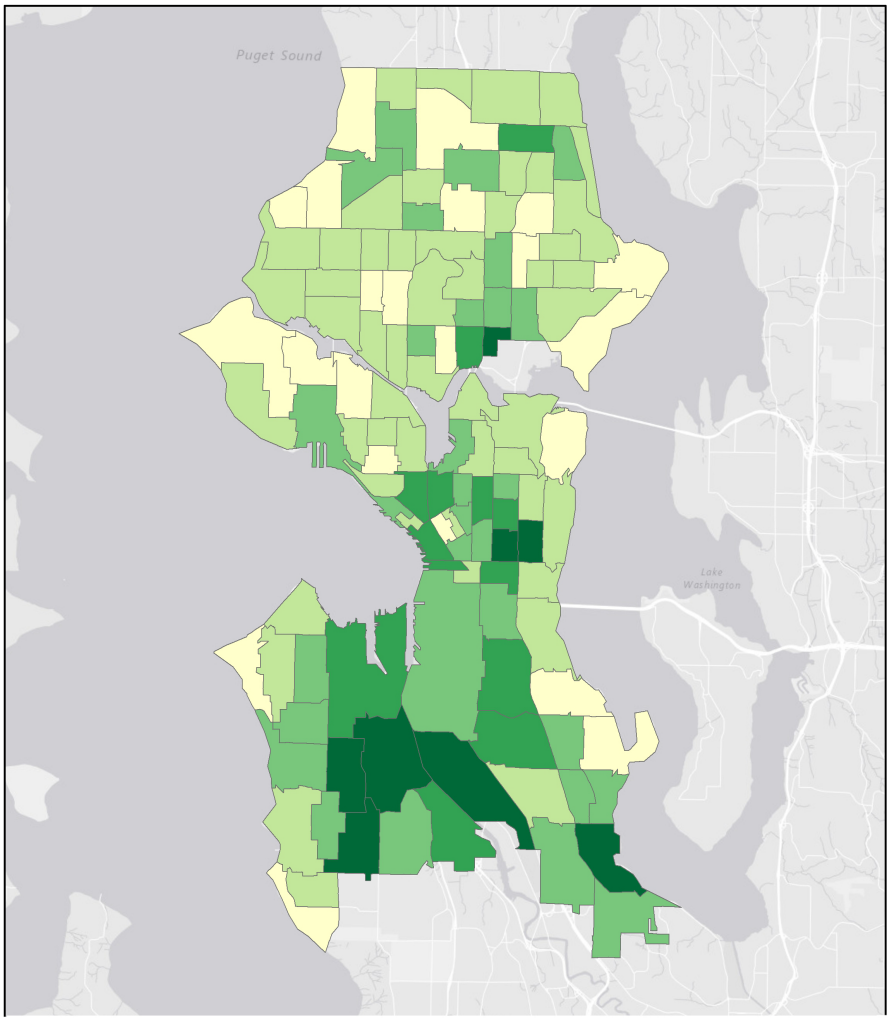
Neighborhood score on disadvantage index

SUPP FIGURE 1.2. NEIGHBORHOOD ENDORSEMENT OF "CODE OF THE STREETS", BASED ON SNCS



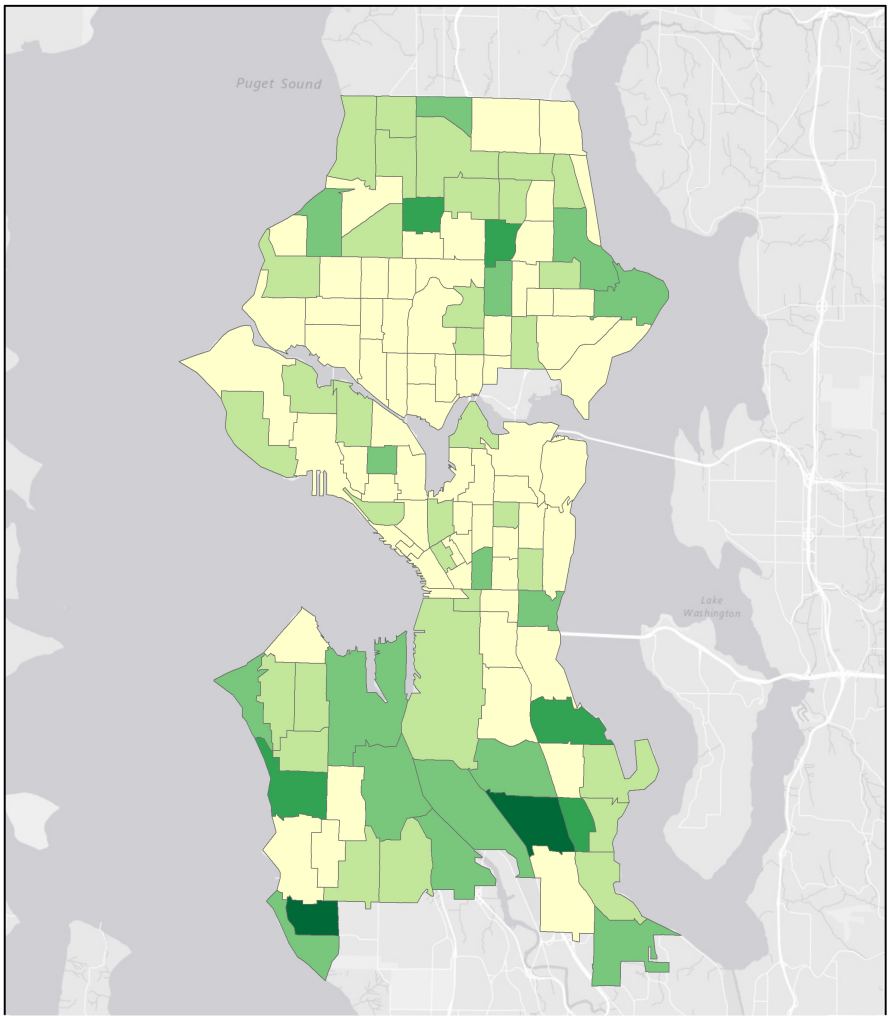
Neighborhood score endorsing the "code of the streets"

SUPP. FIGURE 1.3. NEIGHBORHOOD FEAR OF CRIME, BASED ON SNCS



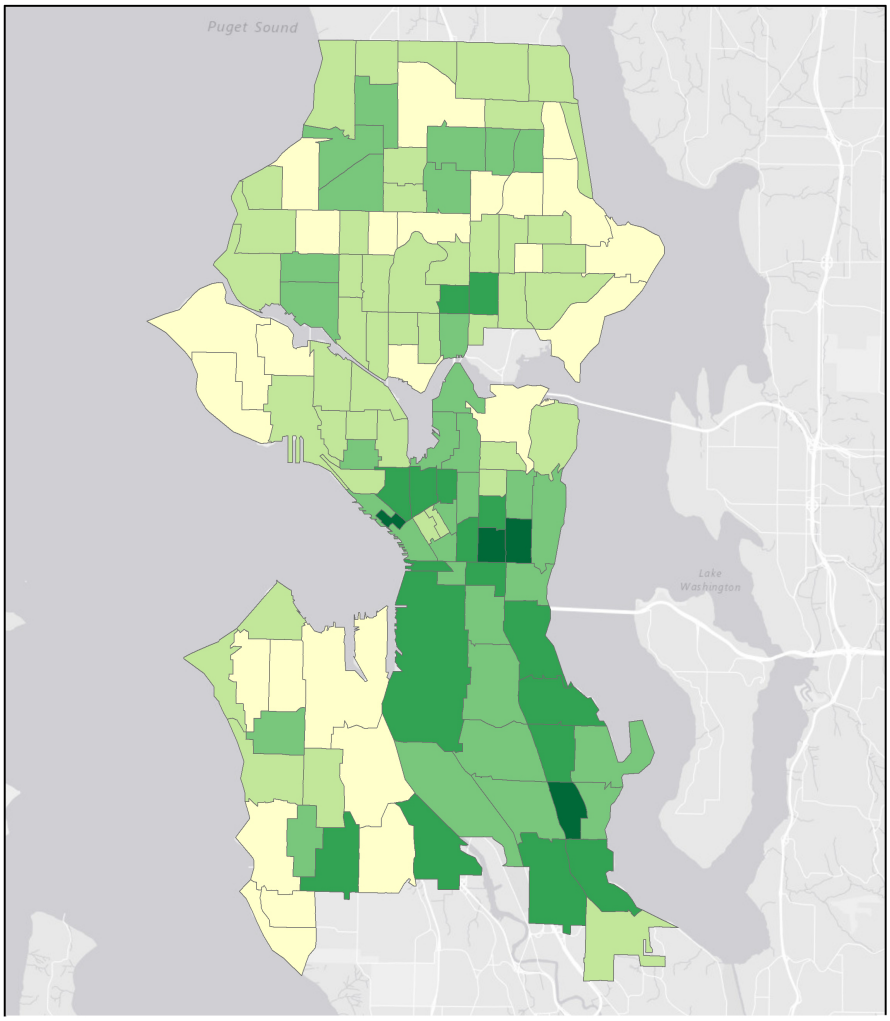
Neighborhood scores on fear of crime

SUPP. FIGURE 1.4. HANDGUN OWNERSHIP, BASED ON SNCS



Neighborhood residents who own handguns (%)

SUPP. FIGURE 1.5. NEGATIVE OPINIONS OF POLICE, BASED ON SNCS



Neighborhood score on negative opinions of the police

THE SEATTLE NEIGHBORHOOD AND CRIME SURVEY

Description of methodology and sampling strategy(1)
(From the Seattle Neighborhoods and Crime Survey User Guide, http://doi.org/10.3886/ICPSR28701.v1)

The Seattle Neighborhoods and Crime Survey collected telephone survey data on households in the city of Seattle. Three separate sampling frames were used. First, the "Random Sample" was used to obtain a random sample of households within each of 123 census tracts in Seattle. This sample randomly selected two block groups from each of 123 census tracts and then randomly selected approximately nine households per block groups. This resulted in a sample of 2,220 households. Second, the "Ethnic Oversample" was used to obtain a disproportionate number of households within neighborhoods with high percentages of racial and ethnic minorities. The investigators identified the 141 block groups with the highest concentration of racial and ethnic minorities in Seattle. They then selected the 558 census blocks within these block groups with the highest racial and ethnic minorities, and randomly sampled two households per block. This resulted in a sample of 1,145 households. Third, the "Miethe Replication Sample" began with the 100 census tracts sampled by Terrance Miethe in his 1990 victimization survey [Testing Theories of Criminality and Victimization in Seattle, 1960-1990]. The investigators identified the six street segments in each census tract sampled by Miethe, and drew a random sample of approximately three households per street segment, resulting in a sample of 1,539 households spread over the 100 census tracts. (In a few cases, the street segments were extended slightly to meet the sample quota.) The result is a sample of 4,904 households spread over 123 census tracts. The number of households per census tract ranged from 21 to 110, with a mean of 47.

The sampling frames were designed by the PIs at the University of Washington in consultation with sampling experts. The samples were drawn by the Philadelphia research firm, Genesys,

from their constantly updated white pages. Telephone interviews were conducted by Social and Behavioral Research Institute (SBRI) at California State University, San Marcos, directed by Richard Serpe. SBRI used a modified version of the 15-attempt protocol designed by the Center for Disease Control for the Behavioral Risk Factor Surveillance System Survey, which requires that cases not reached after several calls to be re-attempted at a variety of times of day and days of the week until they are retired as unreachable. If some progress appears to be made, the number of calls would exceed 15. The instrument was translated into Spanish, Vietnamese, and Mandarin, and conducted in the appropriate language by multi-lingual interviewers. All interviews were conducted in late 2002 and early 2003. The AAPOR Cooperation Rate across the three samples was over 97 percent. The CASRO response rate was over 51 percent. The PIs examined the question of non-response bias by collecting supplemental data (not included in the ICPSR dataset). First, for those respondents who refused to participate in the telephone survey, but agreed to fill out a mail-back questionnaire, each was mailed a questionnaire version of the instrument with a return envelope. Just over 500 respondents mailed back their questionnaires. Second, a random sample was drawn of households in each census tract that were not listed in the white pages from which we drew our samples—either because they lacked telephones or they had phones but opted to un-list their numbers. Research assistants were sent to the households to obtain information from paper versions of the instrument. Nearly 400 respondents returned such questionnaires. Analyses suggest that in substantive multi-level models, key substantive results do not differ appreciably across the samples.

The telephone interviews lasted an average of 37 minutes. The instrument included crime victimization questions and follow-ups taken from the National Crime Victimization Surveys, questions on neighborhood attachment taken from Miethe's Victimization Survey, questions on social capital and collective efficacy taken from the Project on Human Development, Communities, and Neighborhoods (e.g., Sampson, Raudenbush, and Earls 1997),(2) questions

on fear of crime and altruistic fear of crime taken from the Texas Poll (e.g. Warr and Ellison 2000),(3) questions on attachment to neighborhoods taken from Guest (e.g., Guest and Lee 1983),(4) and new questions on views of police and violent codes of the street.

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Supp. Table 2.1. Exposure constructs

Exposure	RCW	Charge Description	Count	%
Firearms offenses (N=199)				
	9.41.04*	Firearm possession	166	83.4%
	9A.56.31*	Possession of stolen firearms	14	7.0%
	Flagged	"Firearm"	22	11.1%
	9A.56.30*	Theft of a firearm	1	0.5%
	9.41.05*	Carrying firearms without a concealed pistol license	4	2.0%
	9.41.23*	Aiming/discharging firearms in public	3	1.5%
	9.41.19*	Unlawful firearms	2	1.0%
	9.41.24*	Unlawful use/possession of a pistol by a minor	2	1.0%
	77.15.46*	Unlawful use/possession of a loaded firearm in vehicle	1	0.5%
Domestic violence offenses (N=1143)				
	Flagged	"DomesticViol"	1016	88.9%
	26.50.11*	Domestic violence court order violation	123	10.8%
	9A.36.15*	Interfering w/reporting of domestic violence	4	0.3%
Violent offenses				
Rape (N=23)	9A.44.04-06	Rape	15	65.2%
	9A.44.073*	Rape of a child	1	4.3%
	9A.44.00*	Rape	3	13.0%
	9A.44.076*	Rape of a child - 2	3	13.0%
	9A.44.079*	Rape of a child - 3	1	4.3%
Assault (N=1000)	9A.36.041*	Assault - 4	555	55.5%
	9A.36.00*	Assault	244	24.4%
	9A.36.01*	Assault	29	2.9%
	9A.36.021*	Assault - 2	80	8.0%
	9A.36.031*	Assault - 3	79	7.9%
	9A.36.100*	Custodial assault	6	0.6%
	9A.36.140*	Assault of a child - 3	4	0.4%
	46.61.522*	Vehicular assault	1	0.1%
	9A.36.120*	Assault of a child	2	0.2%
Homicide (N=6)	9A.32.030-050	Murder/homicide	4	66.7%
	9A.32.060*	Manslaughter	1	33.3%
	46.61.520	Vehicular homicide	1	33.3%
Robbery (N=256)	9A.56.21*	Robbery - 2	108	42.2%
	9A.56.20*	Robbery	148	57.8%
DUI				
	46.61.502*	Driving under the influence	294	-
Drug-related offenses (N=2025)				
	69.50.00*	Controlled sub-felony	996	49.2%
	69.50.40*	Possession of a controlled substance	833	41.1%
	69.50.41*	Drug paraphernalia	103	5.1%
	69.00.00*	Drug related charge	26	1.3%
	Flagged	"DrugFinding"	58	2.9%
	69.50.44*	Possession with intent to manufacture	2	0.1%
	69.41.03*	Sale, delivery, or possession of legend drug without prescription or order prohibited	2	0.1%
	69.41.02*	Violation of the Uniform Legend Drug Act	1	0.05%
	69.52.03*	Possession of imitation controlled substance w/intent to distribute	1	0.05%

Supp. Table 2.1. Cont'd

Exposure	RCW	Charge Description	Count	%
	9.94.045*	Possession of contraband in a correctional institution-2	1	0.05%
	69.41.00*	Legend drug violation	1	0.05%
	9A.42.100*	Endangerment with a controlled substance	1	0.05%

^ "Legend drugs" are drugs which are required by state law or regulation of the commission to be dispensed as prescription only or are restricted to use by prescribing practitioners only (RCW 69.41.200)

Supp Table 2.2. Crude odds ratios of intent-specific firearm injury per count category of arrest history

Exposure	Firearm injuries							
	Assault-related		Self-inflicted		Unintentional		Legal Intervention	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
No arrest record	1.00	-	1.00	-	1.00	-	1.00	-
Misdemeanor arrest record only	2.51	(1.73-3.64)	1.18	(0.80-1.75)	1.49	(0.71-3.12)	1.17	(0.33-4.14)
Felony arrest record	6.96	(5.26-9.21)	0.40	(0.26-0.61)	1.75	(0.97-3.15)	6.78	(3.52-13.04)
No arrest record	1.00	-	1.00	-	1.00	-	1.00	-
Nonviolent arrest record only	3.48	(2.58-4.69)	0.72	(0.50-1.03)	1.40	(0.74-2.63)	2.45	(1.08-5.57)
Violent arrest record	8.04	(5.80-11.13)	0.67	(0.43-1.05)	2.04	(1.05-3.97)	8.05	(3.98-16.30)
No firearm arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
Firearm arrest record	9.87	(4.94-19.71)	1.16	(0.44-3.03)	3.40	(1.02-11.35)	3.89	(1.02-14.88)
No DUI arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
DUI arrest record	2.04	(1.31-3.18)	1.13	(0.65-1.96)	1.86	(0.78-4.42)	0.37	(0.05-2.76)
No drug arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
Drug arrest record	5.77	(4.24-7.85)	0.40	(0.24-0.68)	2.06	(1.10-3.87)	3.61	(1.85-7.05)
No domestic violence arrest record^	1.00	-	1.00	-	1.00	-	1.00	-
Domestic violence arrest record	3.93	(2.81-5.49)	0.79	(0.49-1.26)	1.03	(0.45-2.37)	3.61	(1.79-7.29)
Misdemeanor arrest count	1.15	(1.11-1.18)	0.88	(0.83-0.93)	1.05	(0.99-1.11)	1.10	(1.05-1.17)
Felony arrest count	1.34	(1.27-1.43)	0.79	(0.70-0.90)	1.15	(1.03-1.28)	1.32	(1.20-1.44)
Nonviolent arrest count	2.09	(1.30-3.38)	0.45	(0.19-1.08)	1.14	(0.37-3.49)	inf.	-
Violent arrest count	1.64	(1.45-1.86)	0.84	(0.69-1.03)	1.27	(1.01-1.60)	1.58	(1.32-1.89)
Firearm arrest count	4.97	(2.84-8.67)	1.42	(0.70-2.87)	3.09	(1.38-6.94)	2.27	(0.75-6.87)
DUI arrest count	1.27	(1.06-1.52)	0.89	(0.68-1.17)	1.40	(1.08-1.82)	0.61	(0.21-1.84)
Drug arrest count	1.32	(1.23-1.42)	0.72	(0.61-0.85)	1.15	(1.01-1.31)	1.18	(1.03-1.36)
Domestic violence arrest count	1.39	(1.24-1.57)	0.81	(0.66-0.99)	1.14	(0.91-1.44)	1.34	(1.12-1.62)

All ORs were obtained from multinomial logistic regression models in which the unintentional MVC passenger injury served as the control group

^ includes those with other types of arrest.

Supp Table 3.1. Injury group definitions by ICD code

Study group	Contributing ICD-9 e-codes	Contributing ICD-10 codes
Assault-related firearm injury	E965.xx	X93-X95
Self-inflicted firearm injury	E955.xx	X72-X74
Unintentional firearm injury	E922.xx	W32-W34
Legal intervention firearm injury	E970	Y35-Y36
Unintentional MVC passenger injury*	E810.xx-E819.xx	V00-V79

* Limited to passenger injuries based on ICD-9 codes ending in ".1", coded transportation role, or injury description

Supp. Table 3.2. Diagnosis exposures, based on DSM-IV categories

Exposure category	ICD-9 code	Code Description	N	%
Alcohol use (N=64)				
	303.xx	Acute dependence syndrome	40	62.50
	305.0x	Nondependent alcohol abuse	24	37.50
Cannabis use (N=16)				
	305.2x	Nondependent cannabis abuse	12	75.00
	304.3x	Cannabis dependence	4	25.00
Other substance use (N=81)				
	305.6x	Nondependent cocaine abuse	19	23.46
	304.0x	Opioid type dependence	14	17.28
	304.2x	Cocaine dependence	11	13.58
	305.9x	Nondependent other, mixed, or unspecified drug abuse	9	11.11
	305.5x	Nondependent opioid abuse	8	9.88
	304.7x	Combinations of opioid type drug w/any other drug dependence	5	6.17
	305.7x	Nondependent amphetamine/related sympathomimetic abuse	5	6.17
	304.1x	Sedative, hypnotic or anxiolytic dependence	3	3.70
	304.9x	Unspecified drug dependence	2	2.47
	304.4x	Amphetamine/other psychostimulant dependence	1	1.23
	304.5x	Hallucinogen dependence	1	1.23
	304.6x	Other specified drug dependence	1	1.23
	305.3x	Nondependent hallucinogen abuse	1	1.23
	305.4x	Nondependent sedative, hypnotic or anxiolytic abuse	1	1.23
	304.8x	Combinations of drug dependence excluding opioid type drug	0	-
	305.8x	Nondependent antidepressant type abuse	0	-
Psychotic disorders (N=36)				
	298.xx	Other nonorganic psychoses	21	58.33
	295.xx	Schizophrenic disorders	13	36.11
	297.xx	Delusional disorders	2	5.56
	293.81	Psychotic disorder w/delusions in conditions classified elsewhere	0	-
	293.82	Psychotic disorder w/hallucinations in conditions classified elsewhere	0	-
Disruptive, impulse-control and conduct disorders (from DSM-V) (N=7)				
	301.7x	Antisocial personality disorder	3	42.86
	301.3x	Explosive personality disorder	2	28.57
	301.83	Borderline personality disorder	1	14.29
	312.xx	Disturbance of conduct not elsewhere classified	1	14.29
	313.81	Oppositional defiant disorder	0	-
Depression/mood disorders (N=101)				
	296.xx	Episodic mood disorders	57	56.44
	311.xx	Depressive disorder, not elsewhere classified	24	23.76
	300.xx	Anxiety, dissociative and somatoform disorders	20	19.80
	293.83	Mood disorder in conditions classified elsewhere	0	-
	301.13	Cyclothymic disorder	0	-

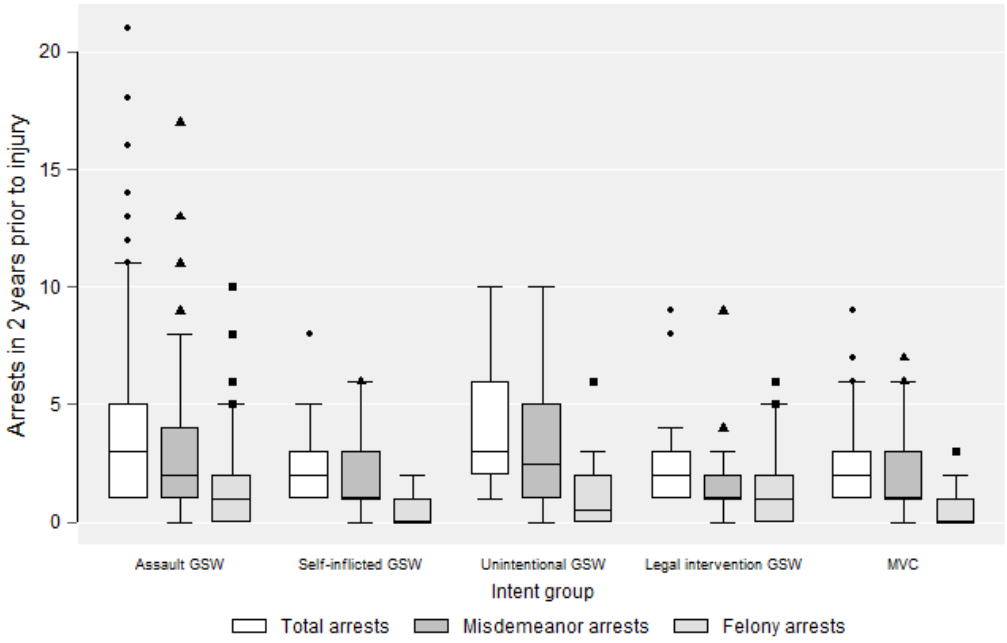
Based on total diagnoses; a single visit may involve multiple diagnoses

Supp. Table 3.3. Arrest categories based on RCW charges and degree

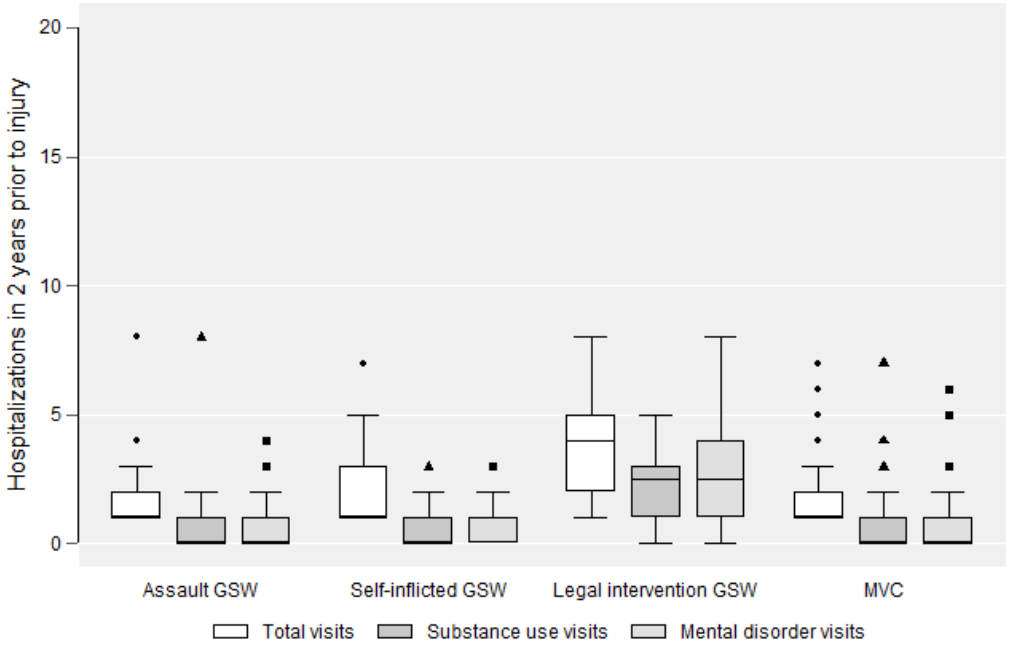
RCW	Charge Description	Misdemeanor charges N=1278		Felony charges N=419	
		N	%	N	%
Drug-related charges		**70**		**123**	
69.50.40x	Possession of a controlled substance	43	62.32	65	52.42
69.50.41x	Drug paraphernalia	22	31.88	-	-
69.50.00x	Controlled substance violation	3	4.35	58	46.77
69.41.03x	Sale/possession of legend drug w/o prescription^	1	1.45	-	-
9A.42.100	Endangerment with a controlled substance	1	0.81	-	-
Violent crime charges		**110**		**71**	
9A.36.011-041, 120-140	Assault	110	100	24	33.8
9A.56.200-210	Robbery	-	-	43	60.56
9A.44.04-06	Rape	-	-	3	4.23
46.61.520	Vehicular homicide	-	-	1	1.41
Other charges		**2218**		**207**	
35/36.00.000	County/municipal code violation	420	38.22	-	-
46.20.xxx	Drivers license-related violations	165	15.01	-	-
9A.56.xxx	Theft, excluding robbery	104	9.46	43	19.2
46.61.xxx	Traffic violations (incl. reckless driving/DUIs)	78	7.1	4	1.79
9A.76.xxx	Obstructing governmental operation	65	5.91	2	0.89
9A.48.070-090	Malicious mischief	44	4	4	1.79
26.50.110	Domestic violence court order violation	42	3.82	7	3.13
9A.52.xxx	Burglary and trespass	36	3.28	91	40.63
66.44.xxx	Alcohol-related violations	27	2.46	-	-
46.52.0xx	Hit and run	23	2.09	-	-
9A.88.xxx	Indecent exposure/prostitution-related violations	22	2	1	0.45
9A.46.xxx	Harassment/stalking/no-contact order violations	19	1.73	12	5.36
9.41.xxx	Firearm/dangerous weapon violations	16	1.46	29	12.95
9.35.000-020	Identity theft	7	3.13	-	-
9A.36.045-110, 150-161	Physical harm violations, excluding assault	6	0.55	1	0.45
9A.84.xxx	Public disturbance	6	0.55	-	-
46.12.xxx	Motor vehicle certificates of title violations	5	0.45	-	-
9.91.025	Unlawful transit conduct	5	0.45	-	-
72.09.310	Community custody violation	4	1.79	-	-
77.15.380	Unlawful recreational fishing	3	0.27	-	-
9A.72.xxx	Perjury and interference with official proceedings	3	1.34	-	-
46.16.160	Vehicle trip permits violation	2	0.18	-	-
46.30.040	Providing false evidence of financial responsibility	2	0.18	-	-
7.21.000	Contempt of court	2	0.18	-	-
9.95.000	Parole violation	2	0.18	-	-
9A.60.000	Fraud	2	0.18	11	4.91
9A.82.000-055	Trafficking in stolen property	2	0.18	2	0.89
10.14.170	Civil anti-harassment protection order violation	1	0.09	-	-
9.68A.090	Communication with minor for immoral purposes	1	0.45	-	-
9.94.070	Persistent prison misbehavior	1	0.45	-	-
9A.44.130	Failure to register as sex offender	1	0.45	-	-

^ “Legend drugs” are drugs which are required by state law or regulation of the commission to be dispensed as prescription only or are restricted to use by prescribing practitioners only (RCW 69.41.200)

SUPP FIGURE 3.1A. NUMBER OF WA ARRESTS IN 2 YEARS PRIOR TO INJURY, BY INJURY GROUP



SUPP FIGURE 3.1B. NUMBER OF WA HOSPITALIZATIONS IN 2 YEARS PRIOR TO INJURY, BY INJURY GROUP



No unintentional firearm injury subjects had a hospitalization record in the 2 years prior to index injury.

Supp Table 3.4. Odds ratios for prior arrests or diagnoses by intent-specific firearm injury, unadjusted

	Arrests and diagnoses in prior 2 years	Firearm injuries: Assault-related OR (95% CI)	Firearm injuries: Self-inflicted OR (95% CI)	Firearm injuries: Legal Intervention OR (95% CI)
Substance use	No alcohol-related diagnoses^	Ref	Ref	Ref
	Alcohol-related diagnoses	0.50 (0.18, 1.41)	2.87 (1.24, 6.61)	5.37 (1.55, 18.57)
	No cannabis-related diagnoses^	Ref	Ref	Ref
	Cannabis-related diagnoses	0.76 (0.11, 5.39)	2.32 (0.39, 14.02)	11.48 (1.56, 84.54)
	No other substance-related diagnoses^	Ref	Ref	Ref
	Other substance-related diagnoses	0.44 (0.19, 1.02)	0.60 (0.23, 1.58)	2.29 (0.62, 8.37)
Mental disorder	No depression-related diagnoses^	Ref	Ref	Ref
	Depression/mood-related diagnoses	0.34 (0.14, 0.85)	2.04 (1.01, 4.10)	3.16 (0.98, 10.19)
	No psychosis-related diagnoses^	Ref	Ref	Ref
	Psychosis-related diagnoses	0.75 (0.24, 2.36)	1.02 (0.29, 3.67)	5.88 (1.39, 24.76)
	No impulse/conduct-related diagnoses^	Ref	Ref	Ref
	Impulse/conduct-related diagnoses	2.27 (0.24, 21.93)	- (0, ∞)	23.01 (2.03, 261.15)
Arrest	No arrest history	Ref	Ref	Ref
	Misdemeanor arrests only	2.89 (1.90, 4.41)	0.54 (0.28, 1.02)	2.87 (1.06, 7.79)
	Felony arrests	10.34 (5.89, 18.15)	0.47 (0.17, 1.33)	10.61 (4.03, 27.93)

All ORs were obtained from multinomial logistic regression models in which the unintentional MVC passenger injury served as the control group. Unintentional firearm injury subjects were not included in analyses of prior diagnoses. In the model comparing prior arrests, unintentional firearm injury subjects were no more likely than MVC passenger controls to have a prior misdemeanor arrest (OR 1.30, 95% CI 0.59-2.85) but were more likely to have a prior felony arrest (OR 3.20, 95% CI 1.33-7.70).

^ includes those with other types of diagnoses

Supp Table 3.5. Odds ratios for prior arrests or diagnoses by intent-specific firearm injury, adjusted for age, gender, and race, Referent group: assault-related firearm injuries

	Arrests and diagnoses in prior 2 years	Self-inflicted firearm injuries		Legal Intervention firearm injuries	
		OR	(95% CI)	OR	(95% CI)
Substance use	No alcohol-related diagnoses^	Ref		Ref	
	Alcohol-related diagnoses	2.85	(0.92, 8.79)	7.38	(1.78, 30.50)
	No cannabis-related diagnoses^	Ref		Ref	
	Cannabis-related diagnoses	3.85	(0.41, 36.17)	17.41	(1.83, 165.95)
	No other substance-related diagnoses^	Ref		Ref	
	Other substance-related diagnoses	0.79	(0.22, 2.79)	4.36	(0.99, 19.13)
Mental disorder	No depression-related diagnoses^	Ref		Ref	
	Depression/mood-related diagnoses	2.70	(0.87, 8.37)	8.44	(2.04, 34.89)
	No psychosis-related diagnoses^	Ref		Ref	
	Psychosis-related diagnoses	1.35	(0.27, 6.70)	8.97	(1.73, 46.58)
	No impulse/conduct-related diagnoses^	Ref		Ref	
	Impulse/conduct-related diagnoses	-	(0, ∞)	19.50	(2.04, 186.81)
Arrest	No arrest history	Ref		Ref	
	Misdemeanor arrests only	0.45	0.23, 0.90)	1.54	(0.55, 4.28)
	Felony arrests	0.12	(0.05, 0.33)	1.67	(0.67, 4.17)

All ORs were obtained from multinomial logistic regression models in which the assault-related firearm injury group served as the referent group. Unintentional firearm injury subjects were not included in analyses of prior diagnoses. In the model comparing prior arrests, unintentional firearm injury subjects were no more likely than firearm assault subjects to have a prior misdemeanor arrest (OR 0.55, 95% CI 0.25-1.19) and less likely to have a prior felony arrest (OR 0.38, 95% CI 0.17-0.81).

^ includes those with other types of diagnoses

Supp Table 3.6. Odds ratios for prior arrests or diagnoses by intent-specific firearm injury, adjusted for age, gender, and race, Referent group: self-inflicted firearm injuries

	Arrests and diagnoses in prior 2 years	Assault-related firearm injuries		Legal Intervention firearm injuries	
		OR	(95% CI)	OR	(95% CI)
Substance use	No alcohol-related diagnoses^	Ref		Ref	
	Alcohol-related diagnoses	0.35	(0.11, 1.08)	2.59	(0.75, 8.89)
	No cannabis-related diagnoses^	Ref		Ref	
	Cannabis-related diagnoses	0.26	(0.03, 2.44)	4.52	(0.62, 33.20)
	No other substance-related diagnoses^	Ref		Ref	
	Other substance-related diagnoses	1.26	(0.36, 4.46)	5.51	(1.17, 26.01)
Mental disorder	No depression-related diagnoses^	Ref		Ref	
	Depression/mood-related diagnoses	0.37	(0.12, 1.15)	3.12	(0.89, 11.01)
	No psychosis-related diagnoses^	Ref		Ref	
	Psychosis-related diagnoses	0.75	(0.15, 3.65)	6.63	(1.25, 35.07)
	No impulse/conduct-related diagnoses^	Ref		Ref	
	Impulse/conduct-related diagnoses	-	(0, ∞)	-	(0, ∞)
Arrest	No arrest history	Ref		Ref	
	Misdemeanor arrests only	2.22	(1.11, 4.40)	3.40	(1.11, 10.40)
	Felony arrests	8.09	(3.02, 21.72)	13.50	(3.89, 46.83)

All ORs were obtained from multinomial logistic regression models in which the self-inflicted firearm injury group served as the referent group. Unintentional firearm injury subjects were not included in analyses of prior diagnoses. In the model comparing prior arrests, unintentional firearm injury subjects were no more likely than self-inflicted firearm injury subjects to have a prior misdemeanor arrest (OR 1.22, 95% CI 0.48-3.12) or a prior felony arrest (OR 3.03, 95% CI 0.92-9.99).

^ includes those with other types of diagnoses