

Firearm Assault Perpetration in King County:  
A Case-Control Study of Antecedent Sentinel Events

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**Abstract**

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**Background:** Sentinel events preceding firearm perpetration events could be potential points of intervention to prevent injury and death related to firearm in King County.

**Objective:** To compare risks of firearm perpetration among perpetrators of violent crime, and compare risk of fatal shootings among firearm perpetrators of violent crime.

**Study Design:** Case-control study.

**Setting and Subjects:** Study was conducted in 7 police jurisdiction encompassing 95% of all firearm violent crime cases from 2006 – 2016 within King County, Washington. Cases were individuals who perpetrated with a firearm, and control were individuals who perpetrated without

a firearm. Additionally, fatal shootings were defined firearm crimes where the victims deceased, and nonfatal shootings were firearm crimes where victims did not de cease.

**Result:** There were 208 firearm perpetrators and 738 non-firearm perpetrators identified for the study, with 55 fatal shootings and 153 nonfatal shootings. Between firearm perpetrators and non-firearm perpetrators, significant risk factors include juvenile criminal history, adult criminal history, history of firearm injury, education, and number of co-offenders. Between fatal and nonfatal shootings, fatal shooting is associated with type of firearm, history of criminal conviction, drug and alcohol intoxication, and previous exposure to firearm injury.

**Conclusion:** Previous criminal history is associated with an increased risk for firearm perpetration and fatal shootings. Further research should be conducted on interventions and prevention strategies in the criminal justice system, law enforcement agencies, public health institutions, and hospital settings.

**Overview:** The rates of violent crime, defined by the Federal Bureau of Investigation<sup>1</sup> as murder and non-negligent manslaughter, forcible rape, robbery, and aggravated assault, have declined significantly in the United States<sup>1, 2</sup>. As much as a 12.3 percent drop was observed from 2009 – 2013, and a 14.5 percent drop from 2004 – 2013.<sup>2</sup> Nonetheless, the United States still has a fairly high rate of homicide, with 5.62 homicides per 100,000 persons from 2003- 2015.<sup>3</sup> Firearm mortality accounts for 70% of all homicides of people ages 17 to 25 years, making this age group the most disproportionately affected by firearm deaths in the United States.<sup>4</sup> With 97,977 homicides reported from 2009 to 2014, firearms are responsible for about 70% of the mechanism of homicide.<sup>3</sup> Moreover, firearms are frequently used in the commission of other violent crimes and often used in crimes such as robbery or assault.<sup>5</sup>

It is a challenging task to prevent fatal and nonfatal interpersonal firearm violence. Even though the overall violent crime rate in King County have been seeing a downward trend<sup>6</sup>, the county experienced a 29.4% increase in firearm violence – defined as violent crime committed with a firearm – from 2011 – 2015 compared with previous years.<sup>6</sup> From 2014 – 2015 alone, there was a 19.4% increase in firearm violence compared to the previous years. The King County Prosecuting Attorney’s Office, various Police Departments and King County Sheriff’s Office, and King County Jail carried the burden of managing the rise in firearm violence. Thus, the County Executive wishes to adopt a public health approach to the problem, aimed at developing evidence-based strategies to prevent injuries and deaths due to firearm.<sup>7</sup> Firearm violence has been associated with various risk and protective factors. The delivery of appropriately focused and comprehensive prevention services depends on the identification of youth and adults at highest risk of perpetrating firearm violence. However, there is limited research done on sentinel events preceding firearm-related assault, especially on the sentinel events that were only days, hours, or even seconds prior the firearm incident.

**Purpose:** The purpose of the study was to gain insight into factors associated with perpetrating firearm violence within King County. The population of interest included individuals aged 18 - 29 residing in King County who committed first-degree assault, second-degree assault, first-degree manslaughter, second-degree manslaughter, attempted murder, and homicide during 2006 – 2016. The study is aligned with the interest of the National Institute of Justice, which calls for more research into the characteristics of the perpetrators of firearm violence.

There are two specific research aims to this study:

Aim 1: To compare pre-specified characteristics of individuals who committed fatal or non-fatal assault with a firearm with those of individuals who committed fatal or non-fatal assault without a firearm. The primary characteristics of interest include demographic profile of perpetrators, education attainment, criminal history, drug and alcohol abuse, mental health, and health service utilization.

Aim 2: To compare differences in pre-specified characteristics between fatal and nonfatal firearm event. Comparisons include the demographic profile of the perpetrators, education attainment, substance and alcohol abuse, criminal history, nature of the crime, motive, types of crime, gun used to commit the crime, and the number of victims in the same charge. Additionally, there are comparisons between the perpetration location, the relationship to the victim, and gang affiliations.

### **Hypothesis:**

1. There are differences in demographic profile, criminal history, types of criminal history (violent vs non-violent), public health service utilization, and education attainment between firearm and non-firearm perpetrators. There are also differences amongst firearm events, comparing fatal and nonfatal shootings with regards to demographic profile, criminal history, public health service utilization, and educational attainment.
2. There is a measurable difference in mental health status between firearm and non-firearm perpetrators. The mental health status of interest would be mood disorders, psychosis, and displayed aggression. Among firearm perpetrators, the victim's risk of fatality increases if the perpetrators have a previously diagnosed mood disorder, psychosis, and displayed aggression.

3. There is a measurable difference in circumstances between the firearm and non-firearm groups, specifically the nature of the crime (domestic, gang-related, drive-by), and the motive of the crime (crime of passion, homicide). Additionally, there are increased risks of victim fatality if the firearm perpetrator committed the crime in certain circumstances mentioned above.

**Study Design:** We conducted a case-control study, comparing demographic information, education attainment, health service usage, previous criminal convictions, domestic violence encounters, mental health history, substance or alcohol abuse, job history, and gang affiliations from administrative data between the firearm perpetration group (FP) and non-firearm perpetration group (NFP). Cases were defined to be individuals age 18-29 who had been convicted of assault or homicide with a firearm from 2006 – 2016 within 7 police jurisdictions in King County from the King County Prosecuting Attorney's Office (KCPAO) database. These jurisdictions were selected due to having the highest prevalence of firearm violence in King County, encompassing over 95% of all violent crimes within the county. The controls were individuals age 18-29 who committed homicide or assault without a firearm in King County from the year 2006 – 2016 within the same 7 police jurisdictions.

From the existing firearm assault perpetration group identified from KCPAO's database, a separate case-control study was conducted to investigate the association of sentinel events and perpetrator's characteristics with fatal and nonfatal shootings. The selected firearm perpetrators were age 18 – 29 and were convicted of homicide with a firearm during 2006 – 2016 within the 7 police jurisdictions in King County. The controls were the perpetrators age 18 – 29 convicted of first-degree and second-degree assault with a firearm during 2006- 2016.

#### Data Linkage

Four main databases were accessed for this research project: Public Health – Seattle and King County (PHSKC) health service data, King County Prosecuting Attorney Office (KCPAO) electronic

court records (ECR), VineProtect protective orders, and King County Jail (KCJ) booking data. . Individuals identified in the ECR were linked with PHSKC Public Health clinic visitation records, PHSKC Emergency Medical Service data, and VineProtect's protection order database using the Microsoft Office's "Fuzzy Matching" add-on, a plugin that allows probabilistic linkage between different tables and is robust to a wide range of variations. Some mistakes tolerated by this software include spelling errors (i.e. Hanah for Hannah), abbreviations (H. for Hannah), hyphenated names (Hannah-Maria to Hannah), shortened names (Rick for Ricky), and missing data.

We first linked individuals' data through deterministic linkage, where first name, last name, birthday, gender, and race must match perfectly. By setting the threshold to "1.000", the fuzzy matching software only accepted matches that were the same in the identified fields and created a table of deterministic matching. ECR and VineProtect have accurate linkage rates for subjects' name (Last, First), date of birth (DOB), gender, and race – thus deterministic linkage was employed to match the two databases. In databases where variables have high variance among variables, probabilistic matching was employed to ensure correct linkage was established. The fuzzy matching threshold was then lowered to .80, .70, and .60 to further increase chance of a match found. The matches were then further compared to ensure the individuals were matched correctly, and removed if the matches were incorrect based on the variables linked.

### Statistical Analysis

Statistical analyses were performed in Stata version 14.2 (StataCorp). Bivariable and multivariable logistic regression models were used to examine the association of prior sentinel events (e.g., previous criminal records, CPS referrals, EMS response, or protection orders issued) with firearm perpetration status. The multivariable models included age, race, and gender in the analysis.

For the secondary research aim, the firearm assault perpetrators were separated into fatal and non-fatal shooting outcomes. Fatal outcome was determined as shootings where one or more victim sustained fatal injuries.

## Results

Characteristic	Fatal Firearm Perpetration N = 55 (%)	Non-Fatal Firearm Perpetration N = 153 (%)	Total Firearm Perpetration Cases N = 208 (%)	Non-firearm Perpetration Controls N = 738 (%)
<b>Male</b>	50 (90.9)	138 (88.0)	184 (88.4)	677 (91.4)
<b>Race *</b>				
Black	29 (52.7)	96 (62.7)	125 (60.1)	442 (60.1)
Caucasian	24 (43.6)	54 (35.3)	80 (37.5)	278 (37.8)
Asian	2 (3.7)	3 (2.0)	5 (2.4)	18 (2.5)
<b>Fatal Perpetration</b>	55 (100)	0	55 (26.4)	219 (29.7)
<b>Age at conviction</b>				
18 - 21	25 (45.5)	72 (47.0)	97 (46.6)	326 (44.4)
22 - 25	22 (40.0)	36 (23.5)	58 (27.9)	248 (33.7)
26 - 29	8 (14.5)	45 (29.4)	53 (25.5)	161 (21.9)
<b>Crime type</b>				
Assault 1	3 (5.5)	74 (48.4)	77 (37.0)	262 (35.5)
Assault 2	3 (5.5)	72 (47.0)	75 (36.1)	253 (34.4)
Manslaughter 1	21 (38.1)	0	21 (10.1)	91 (12.4)
Manslaughter 2	25 (45.5)	0	25 (12.0)	96 (13.0)
Attempted Murder	0	7 (4.6)	7 (3.3)	29 (3.9)
Homicide	3 (5.5)	0	3 (1.4)	7 (1.0)
<b>Education (Grade Level)</b>				
Primary (1 - 6)	3(5.5)	7 (4.6)	10 (4.8)	14 (1.9)
Middle (7 - 9)	23 (41.8)	56 (36.6)	79 (38.0)	41 (5.6)
High (10 - 11)	15 (27.3)	52 (34.0)	67 (32.2)	456 (62.0)
12 and 12 +	14 (25.4)	38 (24.8)	52 (25.0)	227 (30.9)
<b>History of Conviction</b>				
No Criminal History	15 (27.3)	60 (39.2)	75 (36.1)	465 (63.0)
Ever convicted of any crime	40 (72.7)	93 (60.8)	133 (63.9)	273 (37.0)
1 - 3 convictions	20 (36.4)	50 (32.7)	70 (33.7)	177 (24.0)
4 - 6 convictions	8 (14.5)	30 (19.6)	38 (18.3)	80 (10.8)
7 + convictions	12 (21.8)	14 (8.5)	26 (12.5)	16 (2.2)
History of Any Violent Crime	22 (40.0)	32 (20.9)	55 (31.3)	150 (19.4)
<b>Juvenile criminal history</b>				
No Juvenile Conviction	35 (63.6)	106 (69.3)	141 (67.8)	570 (77.2)
Ever Juvenile Conviction	20 (36.4)	47 (30.7)	67 (32.2)	168 (22.8)
1 - 3	11 (20.0)	34 (22.2)	45 (21.6)	124 (16.8)
4 - 6	2 (3.6)	9 (5.9)	11 (5.3)	37 (5.0)
7+	7 (12.7)	4 (2.6)	11 (5.3)	7 (0.9)
Violent juvenile history	13 (23.6)	36 (23.5)	49 (23.6)	120 (16.2)
<b>Adult criminal history</b>				
NO Adult Crime	19 (34.5)	88 (57.5)	107 (51.4)	586 (79.4)
Ever	36 (65.5)	65 (42.5)	101 (48.6)	170 (20.6)
1 - 3	22 (40.0)	37 (24.2)	59 (28.4)	105(14.2)
4 - 6	10 (18.1)	26 (17.0)	36 (17.3)	62(8.4)
7+	4 (7.3)	2 (1.3)	6 (2.9)	3(>0.1)
Violent adult criminal history	24 (43.6)	27 (17.6)	51 (24.5)	53 (7.2)
Average time to assault (months)	22.5 (13.2)**	26.97 (14.8)**	25.8 (14.4)**	25.9 (13.7)**
<b>Co-Offenders</b>				
Committed alone (0)	13 (23.6)	46 (30.0)	59 (28.4)	264 (35.8)
1	23 (41.8)	67 (43.8)	90 (43.3)	340 (46.1)
2	17 (30.9)	29 (19.0)	46 (22.1)	104 (14.1)
3+	2 (4.6)	11 (7.2)	13 (6.3)	30 (4.1)
<b>Gang Affiliation (ECR)</b>	14 (25.5)	39 (25.5)	53 (25.5)	145(19.6)
<b>Drug Involvement (ECR)</b>				
<b>Ever</b>	29 (52.7)	50 (32.7)	79 (38.0)	193 (26.2)
Alcohol	20 (36.4)	41 (26.8)	61 (29.3)	179 (24.3)
Opiate	9 (16.4)	9 (5.9)	18 (8.7)	49 (6.6)
<b>Public Health Service Accessed</b>				
Never	29 (52.7)	92 (60.1)	121 (7.1)	415 (56.2)
Ever	26 (47.3)	61 (39.9)	87 (41.8)	323 (43.8)
1 - 3	13 (23.6)	40 (26.1)	53 (25.5)	205(27.8)
4 - 6	8 (14.5)	15 (9.8)	23 (11.1)	91 (12.3)
7 +	4 (7.3)	6 (3.9)	11 (5.3)	27 (3.7)
History of CPS interaction	9 (16.4)	24 (15.7)	33 (37.9)	123 (37.8)
Parent's Mental Health Flag	14 (25.5)	27 (17.6)	41 (47.1)	165 (50.7)
Parent's Substance Abuse Flag	12 (21.8)	30 (19.6)	42 (48.3)	105 (32.3)
<b>EMS</b>				

No EMS Response	18 (32.7)	53 (34.6)	71	273
Ever EMS response	37 (67.3)	100 (65.4)	137 (65.9)	465 (60.0)
1 - 2 EMS response	27 (49.1)	76 (49.7)	103	338
3 + EMS response	10 (18.2)	24 (15.7)	34 (30.7)	127 (37.9)
<b>Types of EMS Injury</b>				
Firearm injury	28 (50.1)	11 (7.2)	39 (28.5)	5 (1.1)
Assault injury	11 (20.0)	20 (13.1)	31 (14.9)	107 (14.5)
Psychiatric, Neurological or Psychological EMS response	11 (20.0)	32 (20.9)	43 (31.4)	105 (24.0)
Abdominal / Genito-Urinal	0	3 (2.0)	3 (1.4)	8 (1.1)
Accident	3 (5.5)	7 (4.6)	10 (4.8)	25 (3.4)
Alcohol / Drug	3 (5.5)	10 (6.5)	13 (6.3)	66 (8.9)
Anaphylaxis / Allergy	0	1 (0.7)	1 (0.5)	3 (>0.1)
Animal	0	4 (2.6)	4 (1.9)	14 (1.9)
Fall	5 (9.1)	9 (5.9)	14 (6.7)	24 (3.3)
Medical Illness	1 (1.8)	7 (4.6)	8 (3.8)	45 (6.1)
Motor Vehicle / Bicycle	5 (9.1)	11 (7.2)	16 (7.6)	37 (5.0)
Life-support request (Severe EMS response)	5 (9.1)	12 (7.8)	17 (12.4)	61 (13.9)
<b>Location of Crime</b>				
Residential	24 (43.6)	75 (49.0)	99 (47.6)	506 (68.6)
Street	18 (32.7)	48 (31.4)	66 (31.7)	25 (3.4)
Club/Bar	4 (7.3)	7 (4.6)	11(5.3)	19 (2.8)
Gathering	7 (12.7)	18 (11.8)	25 (12.0)	183 (24.8)
Other	1 (1.8)	6 (3.9)	5 (2.4)	7 (0.9)
<b>Type of Firearm Used</b>				
Handgun or pistol	35 (63.7)	123 (80.4)		
Automatic firearm	20 (36.3)	29 (19.0)		
shotgun	0	1 (0.6)		
<b>Civil protection order</b>	3 (5.5)	2 (1.3)	5 (50.0)	2 (25.0)
Returned offense protection order (violated protection order)	2 (3.6)	3 (2.0)	5 (50.0)	2 (25.0)

Table 1 – Characteristic of study population by firearm perpetration status

\*Misclassification of black/African American with Middle Eastern or others

\*\* Values reported are the mean (Standard deviation).

The case-control study included 946 subjects, with a total of 208 cases and 738 controls, all prosecuted within King County from the year 2006 – 2016 for assault to the first degree, assault to the second degree, manslaughter to the first degree, manslaughter to the second degree, attempted murder, and homicide. Fourteen individuals were removed because they did not meet the age requirement (6 individuals), were not prosecuted in King County (4 individuals), or reside outside of King County (2 individuals). Table 1 displays the prevalence of various characteristics and factors associated with each case.

Both the control group and the case group had balanced race distribution, with slight variation in age of conviction of crime. The NFP group had a higher proportion of males than the FP group. 73.1 percent of the FP group and 69.9 percent of the NFP group were convicted of assault to the first and second degree. 22.1 percent of the FP group and 25.4 percent of the NFP group were convicted of

manslaughter to the first and second degree. The variation in prevalence in attempted murder (1.4 percent in FP versus 3.9 percent NFP) was found in our study population.

There were other notable differences between the two groups in our study population. The middle-school dropout rate was higher in the FP group (38.0%) than NFP group (5.6%), while the high-school dropout rate was lower in the FP group (32.0%) than NFP group (62.0%). The cases in the study have more interactions with the criminal justice system: higher prevalence of previous criminal history was found in the FP group (64.9%) versus the NFP group (36.7%). Additionally, four in every five cases in the FP group had other adult criminal history (82.4%), compared to three in every five in the NFP group (62.3%). On another note, 28.5% of the FP group experienced gunshot wound prior to their perpetration, compared to 1.1% of the NFP group.

Among the individuals in our perpetrator study population, FP were more frequently observed to have dropped out of school in elementary school (OR, 3.2 [CI 1.1 to 6.0]) or junior high school (OR, 11.8 [CI, 7.3 to 17.1]), possessed a history of juvenile and adult criminal conviction, committed violent crime with 2 other co-offenders (OR, 2.0 [CI 1.3 to 3.1]), had drug and alcohol involvement associated with crime (OR 1.5, [CI 1.1 to 2.1]), and sustained previous firearm injury (OR 2.1, [CI, 1.1 to 3.8]) when compared with NFP. After we controlled for age, gender, and race, the OR of characteristics displayed did not change except for psychological EMS response (OR, 1.5 [CI, 1.1 to 2.4]).

Moreover, the odds of firearm perpetration increased drastically when comparing the count of previous crimes. Those who possessed 7 or more criminal convictions in the past (OR, 9.7 [CI, 1.0 to 18.9]) chose firearm as method of perpetration more frequently than those with 1 to 3 criminal convictions (OR, 2.1 [CI, 1.4 to 3.0]) or 4 to 6 criminal convictions (OR, 3.0 [CI, 1.9 to 4.7]). The trend was the same when we broke down criminal convictions by juvenile and adult criminal convictions. The OR of juvenile criminal convictions differed significantly between FP and NFP when there were

more than 7 counts of juvenile criminal convictions (OR 6.4 [CI, 2.4 to 16.8]). For adult criminal convictions, OR increased between 1 to 3 convictions (OR, 3.1 [CI, 2.1 to 4.5]), 4 to 6 convictions (OR, 4.5 [CI 2.8 to 7.3]), and 7 or more convictions (OR, 11.0, [CI, 2.7 to 44.5]).

Results also differed when comparing fatal and nonfatal shootings among the firearm perpetration group. Several sentinel events have shown significant OR after adjusting for age, gender, and race: using a semi-automatic firearm (OR, 2.5 [CI, 1.3 to 5.0]), drug involvement (OR, 2.7 [CI, 1.7 to 5.3]), opioid involvement (OR, 3.5 [CI, 1.4, 9.3]), having 2 co-offenders (OR 2.5, [CI, 1.0 to 5.7]), criminal convictions, and sustained previous firearm injury (OR, 10.7 [CI, 2.3 to 36.1]). The odds of criminal convictions are significant at 7 or more juvenile conviction (OR, 5.3 [CI, 1.4 to 19.2]), 7 or more adult criminal convictions (OR, 8.9 [CI, 1.5 to 53.0]), and adult violent criminal history (OR, 2.3 [CI, 1.4 to 3.6]) comparing between fatal and nonfatal shootings.

Characteristics (Aim 1)	Bivariate Odds ratio (95% C.I.)	Adjusted Odds Ratio (95% C.I.)
<b>Gender</b>		
Male	1.1 (0.7, 1.9)	1.3 (0.8, 2.1)
Female	1.00 (ref)	1.00 (ref)
<b>Age at conviction</b>		
18 – 21	1.0 (ref)	1.0 (ref)
22 – 25	0.8 (0.5, 1.1)	0.8 (0.5, 1.1)
26 – 29	1.1 (0.8, 1.6)	1.0 (0.7, 1.8)
<b>Education (Grade Level)</b>		
1 – 6 (Primary)	3.2 (1.1, 6.0)	3.2 (1.4, 7.7)
7 – 9 (Middle)	11.4 (7.3, 17.1)	8.5 (5.2, 13.8)
10 – 11 (High)	0.7 (0.5, 1.0)	0.65 (0.4, 0.9)
12 and 12 +	1.0 (Ref.)	1.0 (ref)
<b>Employment (versus none)</b>	1.0 (0.72, 1.5)	1.1 (0.7, 1.5)
<b>Known Gang Affiliation (versus none)</b>	1.4 (0.9, 2.0)	1.4 (1.0, 2.1)
<b>Drug Involvement (ECR)</b>		
No Drug Involvement	1.0 (ref)	
Ever	1.5 (1.1, 2.1)	1.5 (1.1, 2.1)
Alcohol	1.3 (0.9, 1.8)	1.3 (0.9, 1.8)
Opiate	1.3 (0.8, 2.3)	1.3 (0.8, 2.3)
<b>Co-Offenders</b>		
Committed alone (0)	1.0 (ref)	1.0 (ref)
1	1.2 (0.8, 1.7)	1.2 (0.8, 1.7)
2	2.0 (1.3, 3.1)	1.9 (1.2, 3.0)
3+	1.9 (1.0, 3.9)	1.9 (1.0, 3.9)
<b>History of Conviction</b>		
No convictions	1.0 (ref)	1.0 (ref)
Ever convicted of any crime	2.9 (2.1, 4.0)	2.9 (2.1, 4.0)
1 – 3 convictions	2.1 (1.4, 3.0)	2.1 (1.4, 3.0)
4 – 6 convictions	3.0 (1.9, 4.7)	3.0 (1.9, 4.7)
7 + convictions	9.7 (5.0, 18.9)	9.7 (5.0, 18.9)
History of Any Violent Crime	1.6 (1.2, 2.3)	1.6 (1.2, 2.3)
<b>Juvenile criminal history</b>		
No Juvenile Conviction	1.0 (ref)	1.0 (ref)
Ever Juvenile Conviction	1.2 (1.0, 1.4)	1.2 (1.0, 1.4)
1 – 3	1.5 (1.0, 2.2)	1.5 (1.0, 2.2)
4 – 6	1.2 (0.6, 2.4)	1.2 (0.6, 2.4)
7+	6.4 (2.4, 16.8)	6.7 (2.4, 17.7)
Violent juvenile history	1.2 (1.0, 1.4)	1.2 (1.0, 1.4)
<b>Adult criminal history</b>		
No Adult Conviction	1.0 (ref)	1.0 (ref)
Ever convicted	3.6 (2.6, 5.0)	3.7 (2.6, 5.0)
1 – 3	3.1 (2.1, 4.5)	3.1 (2.1, 4.5)
4 – 6	4.5 (2.8, 7.3)	4.5 (2.8, 7.4)
7+	11.0 (2.7, 44.5)	11.1 (2.7, 45.2)
Violent adult criminal history	2.7 (2.0, 3.7)	2.7 (2.0, 3.7)

Average time to assault (months)	1.0 (0.9, 1.0)	1.0 (0.9, 1.0)
<b>Public Health Service Accessed</b>		
Never	1.0 (ref)	1.0 (ref)
Ever	0.9 (0.7, 1.2)	0.9 (0.7, 1.2)
1 – 3	0.9 (0.6, 1.3)	0.9 (0.6, 1.3)
4 – 6	0.9 (0.5, 1.4)	0.9 (0.5, 1.4)
7 +	1.3 (0.6, 2.7)	1.3 (0.6, 2.7)
History of CPS interaction	0.9 (0.6, 1.4)	0.9 (0.6, 1.4)
Parent's Mental Health Flag	1.1 (0.8, 1.7)	1.1 (0.8, 1.7)
Parent's Substance Abuse Flag	1.5 (1.0, 2.3)	1.5 (1.0, 2.3)
<b>EMS</b>		
No EMS Response	1.0 (ref)	1.0 (ref)
Ever EMS response	0.9 (0.6, 1.2)	0.9 (0.6, 1.2)
1 – 2 EMS response	1.0 (0.7, 1.4)	1.0 (0.7, 1.4)
3 + EMS response	0.7 (0.5, 1.1)	0.7 (0.5, 1.1)
<b>Types of EMS Injury</b>		
Firearm injury	2.1 (1.1, 3.8)	2.7 (1.4, 7.1)
Assault injury	0.9 (0.6, 1.3)	0.8 (0.5, 1.7)
Psychiatric, Neurological or Psychological EMS response	1.4 (0.9, 2.2)	1.5 (1.1, 2.4)
Other EMS Response	1.3 (0.5, 1.9)	1.2 (0.4, 1.8)
Life-support request (Severe EMS response)	1.2 (0.7, 2.0)	1.2 (0.7, 2.0)
<b>Pervious protection order</b>	1.0 (0.5, 1.7)	1.0 (0.5, 1.7)
Civil protection order	1.6 (0.9, 2.2)	1.6 (0.9, 2.2)
Returned offense protection order (violated protection order)	1.6 (0.9, 2.2)	1.6 (0.9, 2.2)

Table 2 – Associations between characteristics and firearm perpetration status.

Characteristics (Aim 2)	Bivariate Odds ratio (95% C.I.)	Adjusted Odds Ratio
<b>Male (versus female)</b>	1.1 (0.4, 3.0)	1.3 (0.7, 2.6)
<b>Age at conviction</b>		
18 - 21	1.0 (ref)	1.0 (ref)
22 - 25	2.1 (1.1, 4.0)	2.0 (1.1, 3.8)
26 - 29	0.4 (0.2, 0.9)	0.7 (0.3, 1.2)
<b>Education (Grade Level 1- 12)</b>		
1 - 6 (Primary)	0.7 (0.1, 3.9)	0.7 (0.1, 3.9)
7 - 9 (Middle)	1.2 (0.5, 2.7)	1.2 (0.5, 2.7)
10 - 11(High)	0.8 (0.4, 2.0)	0.8 (0.4, 2.0)
12 and 12 +	1.0 (ref)	1.0 (ref)
<b>Firearm Type</b>		
Handgun and Pistol **	0.5 (0.2, 0.9)	0.5 (0.2, 1.0)
Automatic Firearm**	2.5 (1.3, 5.0)	2.5 (1.3, 5.0)
Shotgun***	---	---
<b>Employment (versus none)</b>	0.9 (0.4, 1.8)	0.9 (0.4, 1.8)
<b>Gang Affiliation</b>	0.9 (0.5, 1.9)	0.9 (0.5, 1.9)
<b>Drug Involvement (ECR)</b>		
No Drug Involvement	1.0 (ref)	1.0 (ref)
Ever	2.6(1.4, 5.0)	2.7(1.4, 5.3)
Alcohol	1.6 (0.8, 3.1)	1.6 (0.8, 3.1)
Opiate	3.2 (1.2, 8.6)	3.5 (1.4, 9.3)
<b>Co-Offenders</b>	1.8 (0.9, 3.6)	
Committed alone	1.0 (ref)	1.0 (ref)
1	1.3 (0.6, 3.0)	1.2 (0.5, 2.9)
2	2.3 (1.0, 5.5)	2.5 (1.0, 5.7)
3+	0.7 (0.1, 3.7)	0.5 (0.1, 3.7)
<b>History of Criminal Conviction</b>		
No convictions	1.0 (ref)	1.0 (ref)
1 - 3 convictions	2.0 (0.9, 4.3)	2.0 (0.9, 4.3)
4 - 6 convictions	1.4 (0.5, 3.5)	1.3 (0.5, 3.5)
7 + convictions	4.0 (1.5, 10.7)	4.2 (1.5, 11.3)
History of Any Violent Crime	1.3 (1.0, 1.6)	1.5 (1.0, 1.8)
<b>Juvenile Criminal History</b>		
No Juvenile Conviction	1.0 (ref)	1.0 (ref)
Ever Juvenile Conviction	1.2 (0.7, 2.6)	1.5(0.7, 2.7)
1 - 3	1.0 (0.4, 2.1)	1.0 (0.4, 2.1)
4 - 6	0.7 (0.1, 3.4)	0.7 (0.1, 3.5)
7+	5.5 (1.5, 19.8)	5.3 (1.4, 19.2)
Violent juvenile history	1.2 (0.9, 1.5)	1.2 (0.9, 1.5)
<b>Adult criminal history</b>		
No Adult Conviction	1.0 (ref)	1.0 (ref)
Ever Adult Crime	2.1 (1.1, 4.0)	2.1 (1.1, 4.0)
1 - 3	2.0 (1.0, 4.1)	1.9 (0.9, 4.0)
4 - 6	1.6 (0.7, 3.9)	1.7 (0.7, 4.0)
7+	8.4 (1.4, 49.1)	8.9 (1.5, 53.0)

Violent adult criminal history	1.8 (1.2, 2.8)	2.3 (1.4, 3.6)
<b>Public Health Service Accessed</b>		
Never	1.0 (ref)	1.0 (ref)
Ever	1.1 (1.0, 1.3)	
1 – 3	0.8 (0.3, 2.2)	0.8 (0.3, 2.2)
4 – 6	1.6 (0.7, 3.4)	1.0 (0.2, 10.6)
7 +	2.1 (0.6, 8.1)	2.0 (0.5, 7.6)
History of CPS interaction	1.1 (0.5, 2.5)	1.0 (0.4, 2.4)
Parent’s Mental Health Flag	1.6 (0.8, 3.4)	1.6 (0.8, 3.4)
Parent’s Substance Abuse Flag	1.2 (0.6, 2.5)	1.2 (0.6, 2.5)
<b>EMS</b>		
No EMS Response	1.0 (ref)	1.0 (ref)
Ever EMS response	0.9 (0.5, 1.8)	0.9 (0.7, 1.1)
1 – 2 EMS response	1.2 (0.6, 2.4)	1.2 (0.6, 2.4)
3 + EMS response	0.6 (0.2, 1.5)	0.5 (0.2, 1.4)
<b>Types of EMS Injury</b>		
Firearm injury	8.8 (2.2, 34.4)	10.7 (2.3, 36.1)
Assault injury	1.6 (0.8, 3.3)	1.5 (0.7, 3.2)
Psychiatric, Neurological or Psychological EMS response	1.0 (0.4, 2.1)	1.0 (0.4, 2.1)
Other EMS Response	1.0 (0.5, 7.4)	1.0 (0.5, 7.4)
Life-support request (Severe EMS response)	1.2 (0.4, 3.6)	1.2 (0.4, 3.6)

\*\*Pistols discharging more than one round (bullet) is classified as a semiautomatic firearm.

\*\*\*Only one case of shotgun is observed in the firearm perpetration cohort.

Table 3 – bivariate and multivariate analysis between fatal and nonfatal cases among firearm perpetration.

## Discussion

Individuals who perpetrated firearm-related violent crimes have experienced different life events than other perpetrators, and lived very different lives than other residents of Seattle and King County. We found that perpetrators who committed assault-related crimes with a firearm were more likely to have had previous criminal convictions when compared to perpetrators who committed violent crimes without firearms. When comparing firearm perpetrators and non-firearm perpetrators, we found that the odds of committing violent crime with a gun were remarkably higher if the individual had an extensive criminal history. After adjusting for age, gender, and race, the odds ratio remained the same for most characteristics.

For the fatal-nonfatal perpetration comparison, we found similar results. The odds ratio for higher counts of past criminal convictions was strongly correlated with fatal perpetration. Drug influence, the number of perpetrators, and the type of firearm used were also associated with fatal firearm perpetration. Previous exposure to firearm injury is noted to be higher in perpetrators that murdered their victims than in those who did not.

Individuals with extensive criminal history are at risk of involvement in later violent and firearm-related crimes.<sup>7-12</sup> Our study shows that not all criminal history has equal weight in terms of risk of firearm perpetration. In our study, adults with adult criminal convictions presented greater risk of firearm perpetration than adults with juvenile criminal convictions. One explanation could be increasing involvement in violence on the personal level, becoming more accustomed to lethal measures and more likely choose a firearm over other weapons.

Other risk factors identified in this study are consistent with other studies done within the US. Education level had been found in some studies to be a risk factor for violence in adolescents and young adults<sup>7,13</sup>, especially in terms of school dropout. We found the risk of firearm perpetration higher among those who dropped out before high school, where most firearm safety and violence

prevention programs were implemented. The results indicate that middle school dropouts are at the highest risk of firearm perpetration, while educational researches are mainly focused on high school suspension or dropouts.

Many studies demonstrate that alcohol and drug dependence is a risk factor for violent and firearm-related crimes, consistent with our finding.<sup>14-16</sup> Our study focused on the direct influence of opiate and alcohol on firearm perpetration, and found associations between opiate, alcohol, firearm perpetration, and shooting fatality. Additionally, we found that alcohol and opiate intoxication can increase the risk of fatal shootings. This finding might be important for prevention work with individuals who are in a culture with common violence and recreational substance use, where fatal shootings are much more likely to occur.

A Washington State-wide investigation previously found that exposure to firearm injury increases the risk of firearm perpetration<sup>12</sup>, coinciding with the results of this study. As evidence in literature suggests, firearm injury may be greater in disadvantaged groups such as our study population. If firearm injury is indeed a strong predictor of future firearm perpetration, it would be a perfect opportunity to engage in interventions that may reduce subsequent firearm perpetration or victimization. Emergency department staff, EMS, law enforcement officers could potentially reduce further recidivism of firearm violence by providing treatment, support, and resources for victims who sustained firearm injury.

Some research examines the choice of firearm among individuals with criminal history, with handguns and pistols a common choice.<sup>16, 17</sup> Our study attempted to capture choice of firearm used in fatal firearm violence, and found the risk of fatal firearm perpetration is higher among those that perpetrate with a semiautomatic firearm than with pistols or other handguns. Further studies on firearm ownership, carrying behaviors, and legality of firearm acquisition can complete the picture on firearm choice and fatality. Understanding the correlation can inform firearm sellers,

policymakers, and law enforcement agencies on the best method of firearm perpetration prevention or elimination.

One aspect of the study finding that was not anticipated was around public health service utilization, such as family planning resources, public health clinics, community nurse outreach programs, or STD health clinics. Our findings indicate that public health service access was not a significant risk or protective factor for firearm perpetration, which could be due to our study population. There may be unforeseen similarities between the two groups of perpetrators, such as their socioeconomic status, availability of community support, or accessibility of public health services. Specific healthcare service or community program utilization would give a more accurate understanding than encompassing the wide spectrum of public health services provided in King County.

Limitations are considered extensively when interpreting the results of the firearm perpetration study. Even though this investigation likely covered over 70% of the convicted cases from 2006 – 2016 in King County, the individuals selected as cases and controls may not accurately reflect the true population in Seattle and King County, Washington. Unlike many studies that use data from the emergency department or trauma records, the individuals were reported cases in the ECR, meaning that reported assault cases may be different than the assault cases where victims sustained injury, but was did not report due to the “anti-snitching” culture in gang community. Shotguns were dropped in statistical analysis, as there was only one count of shotgun as choice of firearm among the 208 firearm perpetrators.

Firearm perpetration can negatively affect an individual physically and psychologically – at times, gun crimes can traumatize a community when they involve a high-profile shooting or mass shooting. This study attempts to assess the risk factors associated solely with firearm perpetration, and demonstrate the importance of cross-agency collaboration in reducing firearm-related

violence. A multi-departmental approach to violence prevention could help cities expand delivery of crime reduction programs, improve cost effectiveness of services available, and remove barriers associated with high risk populations for violent crime perpetration.

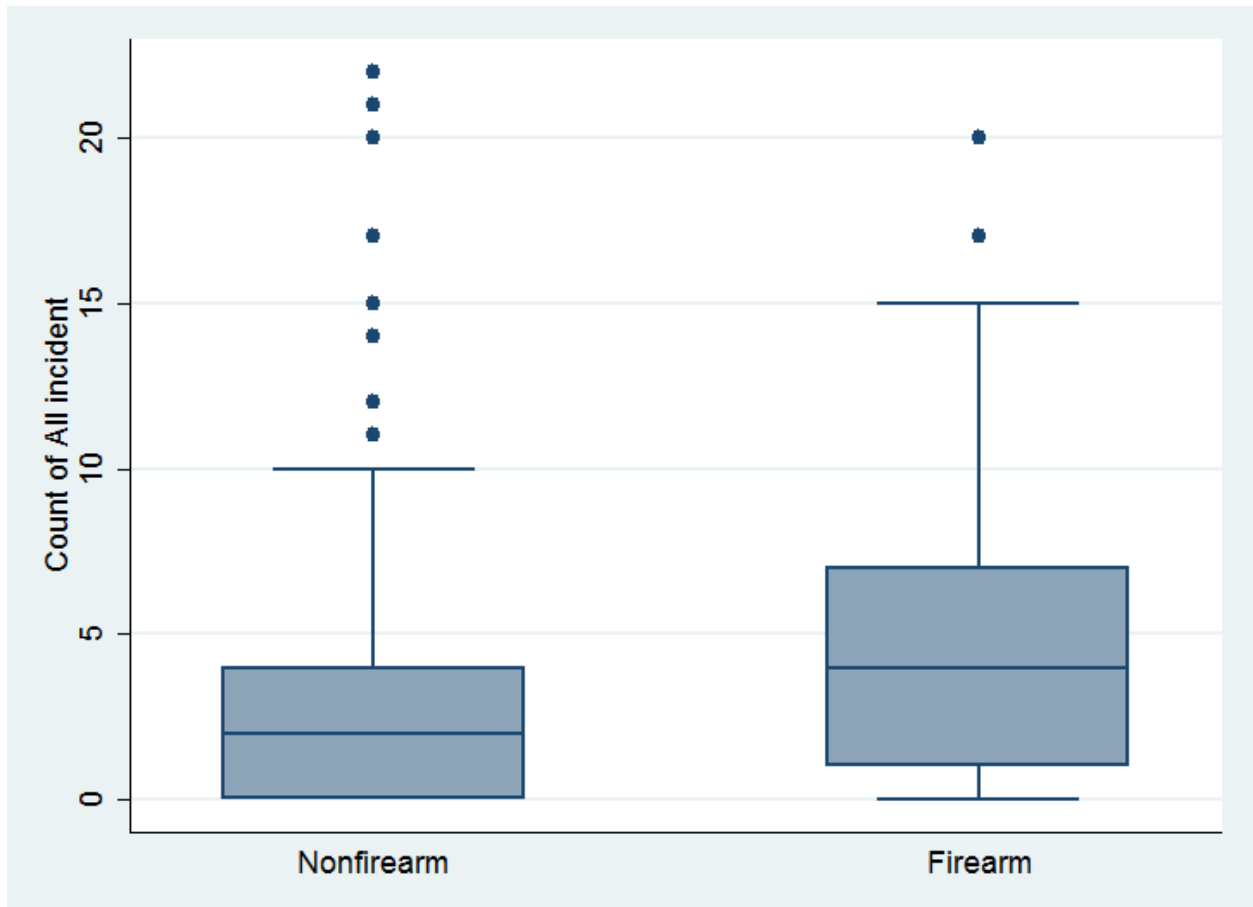


Figure – Box plot displays the distribution of the total number of incident events experienced by cases and controls. Incident events included in the count are CPS referral, EMS response, individual criminal event, PH service utilization, and civil protection violation. The lower, middle, and upper boundary of the box displays the 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentile of the count of all incidents of FP and NFP groups.

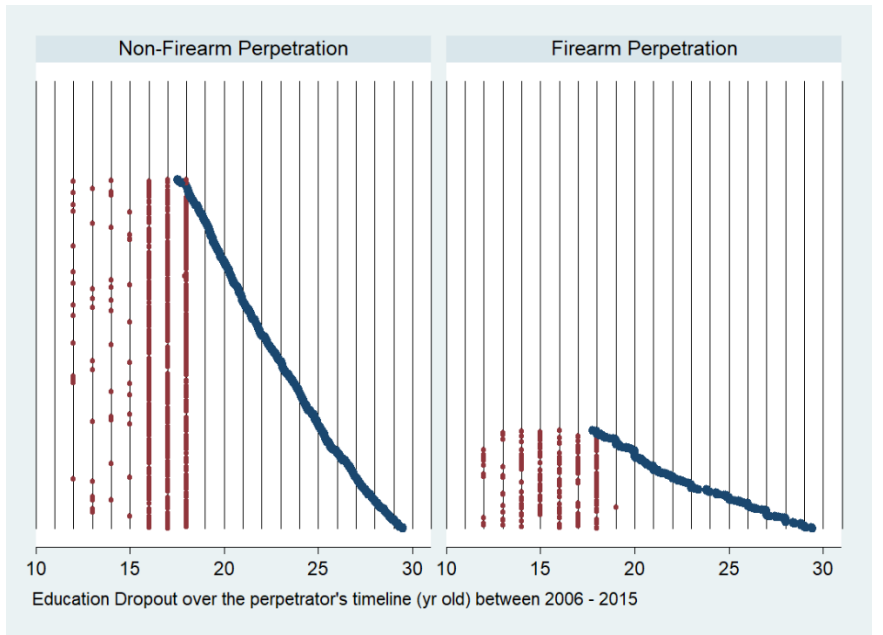
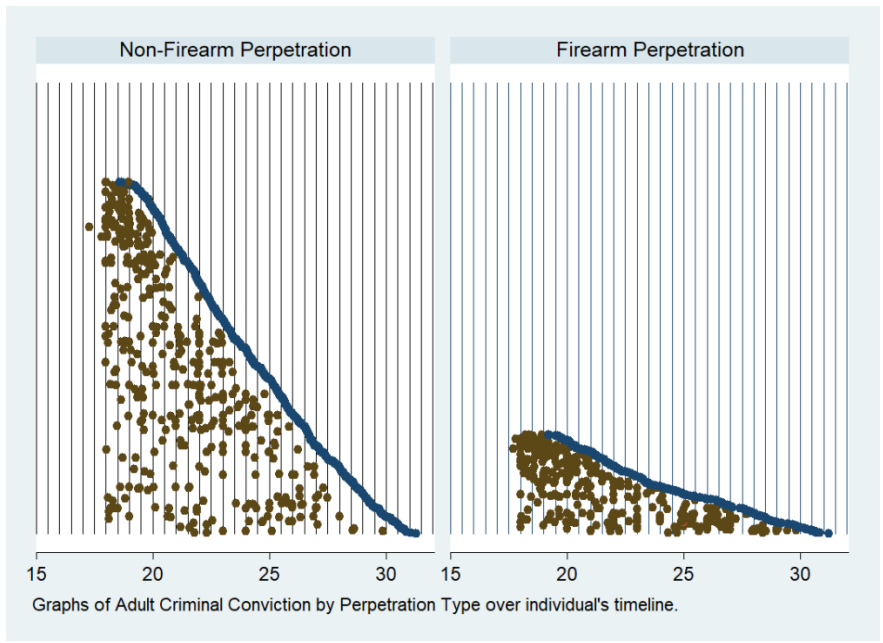


Figure – timeline of sentinel events preceding firearm perpetration for firearm and non-firearm perpetrators in King County.

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Data Accessed

There will be four main databases accessed for this research project: Public Health – Seattle and King County (PHSKC) health service data, King County Prosecuting Attorney Office (KCPAO) electronic court records, VineProtect protective orders, and King County Jail (KCJ) booking data.

Each individual will be searched in the database, using last name, first name, birthdate, and social security number for probabilistic matching. Data points extracted from each administrative database are specified below:

<b>Data Element</b>	<b>Data Description</b>	<b>Data Source</b>
Name	Subject's First and Last name	KCPAO Eletronic Court Records
Birthdate	Birthdate	
Court case #		
Address of subject	Subject's address	
Race	Subject's race	
Sex	Subject's gender	
Education attainment	Subject's highest education attainment	
Gang Affiliation		
Prosecutor's Conviction		
Disposition		
Types of Offense		
Types of Weapons Used in Offense (firearm - which type of gun)		
Age of first offense (Any Crime)		
# prior felony convictions		
# of prior misdemeanor convictions		
# of drug possession (0 = no counts)		
type of drug possession (0= no counts)		
Number of Victims		
Victim Relationship		
Substance or Alcohol Abuse at time of arrest		

SSN	Social Security Number	EMS - Emergency Medical Services (PHSKC)
# of Associates Involved		
PatientName	Name (Last, First)	
PatientDOB	Date of Birth	
PatientGenderID	Gender	
IncidentDate	Date of incident	
ActionTaken	Actions performed by EMS	
AgencyNumber	EMS responding Agency	
AgencyNumberKCEMS	EMS respond ambulance	
AgencyTypeKCEMS	EMS responding type - indication of life support EMS	
DTOnsetSymptoms	Date of Onset of Symptom (provided by patient)	
DTPatientLeftScene	Date and time of patient leaving	
GeocodeAux	Originating code	
IncidentAddress	Incident address	
IncidentApartment	Incident address apartment number	
IncidentCity	Incident city	
IncidentKey	Incident number	
IncidentType	Type of request for response	
IncidentZipCode	Charge Number (charges are numbered sequentially from 1)	
LocationTypeID	Location type (street, resident,	
PatientAddress	Patient Address	
PatientAgeYears	Age of patient at incident	
PatientChiefComplaint	Chief complaint of response	
PatientCity	Patient city of residence	
PatientMechanismCode	Method of injury/sickness	
PatientOutcomeID	Transport, patient left scene, etc.	
PatientTypeCode	Category of injury or sickness	
Respondent Name	Name of individual (last, first)	VineProtect - Database for protection orders
Protected name	Name of protected individual (last, first)	
Birthdate	Date of birth	
Criminal Order	most recent criminal order issued	
Criminal Order Served	most recent criminal order issued date	
# of criminal order	# of criminal order	
Crim Case number	Case number of criminal order if available	
Civil order	Most recent civil order issued	
Civil order date	Most recent civil order issued date	
# of Civil Order	# of Civil Order	
Civ Case number	case number of civil order if available	
Patient Number		

ccn#	Inmate number	Public Health - Seattle and King County
Date of Birth	Date of Birth	
PH Access	Public health service utilization	
PH Access Date First	First date of PH service utilization	
Last public health access (Month)	Month passed since last PH utilization (dated on	
Parental substance abuse	Parent's history of substance use	
Parental mental health flag	Parents' psychiatric or mental disorder flag	
CPS contact	CPS connected families to PH nurses or services	