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RESEARCH ARTICLE

Prior Arrest, Substance Use, Mental Disorder, and Intent-Specific Firearm Injury

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Introduction: Substance use, mental disorders, and arrest are markers of increased firearm injury risk. It is unclear how these markers vary by intent. Examining these interrelated factors together can clarify their associations with assault-related, self-inflicted, unintentional, and legal intervention firearm injuries, informing intent-specific interventions.

Methods: In 2017−2018, 2-year diagnosis and arrest histories of intent-specific firearm injury cases were compared with those of unintentionally injured motor vehicle collision passenger controls. Fatal and nonfatal firearm and motor vehicle collision injury records in Seattle (2010−2014) were linked to statewide hospitalization and arrest records. Multinomial logistic regression models compared odds of prior arrest, substance use, and mental disorder diagnoses among intent-specific firearm injury cases relative to controls, adjusting for age, race, and gender.

Results: A total of 763 cases and 335 controls were identified. Unintentional and self-inflicted cases did not differ significantly from controls in arrest history. Legal intervention cases resembled assault-related cases in their arrest history, and self-inflicted cases in their hospitalization history. The legal intervention cases were more likely than controls to have a prior felony arrest (OR=7.72, 95% CI=2.63, 20.97), and diagnoses involving alcohol (OR=4.06, 95% CI=1.04, 15.84); cannabis (OR=11.00, 95% CI=1.01, 119.36); depression/anxiety (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: Individuals with intent-specific firearm injuries have distinct patterns of prior substance use, mental disorder, and arrest. Many injuries occur after a series of encounters with institutions meant to help individuals during crises that can fail to provide longer-term solutions.
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INTRODUCTION

The burden of firearm injury in the U.S. involves more than interpersonal assault. In 2015, about 20% of nonfatal firearm injuries were unintentional and 61% of firearm deaths were suicides.[1] Although comparatively rare, rates of legal intervention (LI) firearm injuries have increased by about 10% in the past decade.[1] Increased attention and a public health approach are called for to prevent firearm injuries of different intent, including LI injuries.[2,3]

Firearm injuries of different intent share certain risk factors. Prior arrest is associated with increased risk of sustaining assault-related[4,5] and unintentional firearm injuries.[4] Substance use and mental disorders are risk factors for both assault-related[6−9] and self-inflicted[10−14] firearm injuries. Substance use and mental disorders also contribute to LI injuries (including those involving

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firearms)[15–17] as police officers become de facto first responders to individuals in crisis.[16,18,19] Disruptive, impulsive, and conduct-related mental disorders are associated with increased risk of interpersonal and self-directed violence[20–22] and potentially with LI firearm injuries.[23]

Arrest, substance use, and mental disorders may be associated with intent-specific firearm injury in complicated ways, and present differently depending on how each is defined, disaggregated, or analyzed. Substance use is associated with increased risk of arrest.[24,25] Individuals with severe mental disorders have high rates of arrest,[15,26] and mental disorders and substance use are frequently comorbid.[27–31] Therefore, studying arrest history, substance use, and mental disorders in a single investigation can help clarify how each contributes to the risk of sustaining intent-specific firearm injuries.

The goals of this study are to (1) generate an integrated picture of documented prior contacts with the criminal justice and medical systems for intent-specific fatal and nonfatal firearm-injured individuals, and (2) to understand how patterns of arrests and substance use, depression/anxiety, psychosis, and conduct disorder diagnoses prior to injury may serve as risk markers distinguishing intent-specific forms of firearm injury. Contacts with law enforcement and medical professionals prior to injury are potential opportunities for prevention; as such, these professionals should be aware of firearm injury risk markers, and their potential role in reducing multiple forms of firearm injury.

METHODS

Study Design and Population

In this case–control study, firearm injuries (fatal and nonfatal) were divided into four intent-specific case groups: assault-related (including homicide); self-inflicted (including suicide); unintentional; and LI, excluding 16 (1%) injuries with undetermined intent. A population-based control group was infeasible as it would have required access to hospital and arrest records for a sample of Seattle residents and individuals at risk of injury in Seattle. Instead, a hospital-based control group of passengers (not drivers) unintentionally injured in motor vehicle collisions (MVC) was used. This type of injury is unlikely to be the result of the direct actions of the injured person, and risk of injury is likely less strongly influenced by their history of substance use, mental disorders, or arrest. Using MVC passengers allowed for indirect comparisons between intent-specific case groups relative to a single control group.

To ensure cases and controls were drawn from the same underlying population, injuries were restricted to those occurring in Seattle or to Seattle residents, based on injury and residence location ZIP codes (981xx). The study was limited to the first firearm or MVC passenger injury sustained by an individual during January 1, 2010–December 31, 2014 (i.e., "index injury"). Injuries where passenger location was unrecorded were excluded. The exposure period was limited to 2 years prior to injury, as identifiers common to all data sources for linkage purposes were not available prior to 2008. As no arrest records were available for people aged <11 years, the study population was limited to individuals aged ≥13 years at the time of injury to ensure equal exposure time for all people 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–recommended framework[32] for ICD-9/-10 external cause of injury codes (Appendix Table 1, available online). HMC is the Pacific Northwest region's Level 1 trauma center, providing specialized care to patients from several states. Regional surveillance suggests that ≅85% of emergency department visits and 95% of firearm injury hospitalizations in Seattle present to HMC.

Diagnoses from prior hospitalizations were abstracted from the Comprehensive Hospital Abstract Reporting System (CHARS) maintained by the Washington State Department of Health.[33] CHARS records inpatient treatment and observation stays in all state-licensed acute care, long-term, and cancer specialty hospitals in Washington, including psychiatric units. Arrest data were abstracted from the Washington State Identification System criminal history database maintained by the Washington State Patrol.[34] Washington State Identification System aggregates arrest data from local law enforcement agencies across Washington. Integrated deterministic/probabilistic algorithms based on name, date of birth, gender, and social security number were used to identify duplicates and link records in 2008–2014 (Appendix, available online). Study procedures were approved by the University of Washington and Washington State IRBs.

Measures

Substance use and mental disorder diagnoses in the 2 years prior to index injury were identified using ICD-9 codes, excluding hospitalizations <24 hours prior to injury to ensure that exposure predated injury (Appendix Table 2, available online). Each hospitalization involved up to 25 diagnoses. Substance use disorder included diagnoses related to alcohol use, cannabis use, and use of other drugs. Mental disorders included ICD-9 codes 290.xx–319.xx, excluding substance use codes 304.xx–305.xx. Specific mental disorder subcategories of interest were (1) depression/anxiety; (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/anxiety; and (6) impulse-control/conduct disorder if any hospitalization in the previous 2 years included an ICD-9 diagnosis code for that disorder.

Arrests in the 2 years prior to injury were categorized by Revised Code of Washington charges (Appendix Table 3, available online), excluding arrests occurring in the 48 hours before injury to avoid including any incidents that led to both arrest and injury. Arrest history was categorized into a three-level ordinal variable: no arrest history, misdemeanor arrests only, and felony arrests.

Table 1. Select Subject Characteristics by Injury Mechanism and Intent, 2010–2014, Seattle, Washington

Characteristics	Firearm injuries				Unintentional motor vehicle passenger injuries, *n* (%)
	Assault-related, *n* (%) (*n*=443)	Self-inflicted, *n* (%) (*n*=218)	Unintentional, *n* (%) (*n*=71)	Legal intervention, *n* (%) (*n*=31)	
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[a]	65 (63.11)	181 (92.82)	3 (100)	9 (56.25)	16 (64.00)
Age at injury, years					
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 (41.56)	22 (68.75)	34 (55.74)	5 (27.78)	182 (61.07)
Self-pay	19 (5.60)	1 (3.13)	2 (3.28)	1 (5.56)	20 (6.71)
Medicaid/unbilled	179 (52.80)	9 (21.13)	25 (40.98)	12 (66.67)	96 (32.21)
Missing	104	186	10	13	37
Injury severity score					
<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[b]	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[c]	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[c] and arrest	18 (4.06)	7 (3.21)	0 (–)	3 (9.68)	12 (3.58)
Median hospitalization–arrest ratio[d] (range)	0.5 (0.1–2.0)	1(0.5–2.5)	n/a	4 (1.7–8.0)	1 (0.2–6.0)
Median number of hospitals visited[e] (range)	1 (1–3)	1 (1–4)	n/a	2 (1–5)	1 (1–2)
Median days between last hospitalization and injury (IQR)[e]	364 (231–534)	221 (84–426)	n/a	55 (25–364)	273 (132–530)
Median number of arrests (IQR)[f]	3 (1–5)	2 (1–3)	3 (2–6)	2 (1–3)	2 (1–4)
Median days between last arrest and injury (IQR)[f]	151 (67–349)	134 (56–365)	142 (21–423)	126 (63–369)	243 (92–455)
Prior diagnosis of:[g]					
Substance use (all)[e]	13 (34.21)	18 (32.73)	n/a	5 (83.33)	16 (28.57)
Alcohol use[e]	6 (15.79)	16 (29.09)	n/a	4 (66.67)	9 (16.07)
Cannabis use[e]	2 (5.26)	3 (5.45)	n/a	2 (33.33)	2 (3.57)
Other substance use[e]	9 (23.68)	6 (10.91)	n/a	3 (50.00)	15 (26.79)
Mental disorder (all)[e]	14 (36.84)	35 (63.64)	n/a	5 (83.33)	25 (44.64)

(*continued*)

Table 1. Select Subject Characteristics by Injury Mechanism and Intent, 2010–2014, Seattle, Washington (*continued*)

Characteristics	Firearm injuries				Unintentional motor vehicle passenger injuries, *n* (%)
	Assault-related, *n* (%) (*n*=443)	Self-inflicted, *n* (%) (*n*=218)	Unintentional, *n* (%) (*n*=71)	Legal intervention, *n* (%) (*n*=31)	
Depression/anxiety disorders[e]	7 (18.42)	19 (35.55)	n/a	4 (66.67)	15 (26.79)
Psychotic disorders[e]	6 (15.79)	4 (7.27)	n/a	3 (50.00)	6 (10.71)
Conduct disorders[e]	3 (7.89)	0 (0.00)	n/a	2 (33.33)	1 (1.79)
Comorbid substance use and mental disorder[e]	7 (18.42)	14 (25.45)	n/a	4 (66.67)	12 (21.43)
Prior arrest for:[g]					
Misdemeanor offenses (all)[f]	185 (86.05)	18 (94.74)	16 (88.89)	14 (93.33)	47 (88.68)
Felony offenses (all)[f]	127 (59.07)	5 (26.32)	9 (50.00)	9 (60.00)	15 (28.30)

[a]"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.
[b]Includes all subjects who died at scene.
[c]Hospitalizations for any reason, not limited to diagnoses for substance use or mental disorder.
[d]Among subjects with both hospitalization and arrest records.
[e]Among subjects with a hospitalization record.
[f]Among subjects with an arrest record.
[g]Categories not mutually exclusive; a single visit/arrest may involve multiple diagnoses/charges.
IQR, interquartile range; n/a, not applicable.

Table 2. ORs for Prior Arrests or Diagnoses by Intent-Specific Firearm Injury

Arrests and diagnoses in prior 2 years	Assault-related, OR (95% CI)	Self-inflicted, OR (95% CI)	Legal intervention, OR (95% CI)
Substance use			
No alcohol-related diagnoses[a]	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[a]	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[a]	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/anxiety diagnoses[a]	ref	ref	ref
Depression/anxiety diagnoses	0.82 (0.29, 2.33)	**2.85 (1.20, 6.73)**	**7.22 (1.89, 27.67)**
No psychosis-related diagnoses[a]	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[a]	ref	ref	ref
Impulse/conduct-related diagnoses	1.35 (0.12, 14.61)	– (0.00, ∞)	**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)**

Note: Boldface indicates statistical significance ($p<0.05$). 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).
[a]Includes those with other types of diagnoses.
MVC, motor vehicle collision.

Statistical Analysis

Multinomial logistic regression was used to estimate the magnitude of associations between sustaining an intent-specific firearm injury (compared with an unintentional MVC passenger injury) and prior arrest, substance use disorder, or mental disorder diagnosis. Each exposure was modeled separately (Appendix Table 4, available online) and adjusted for a minimum set of pre-specified potential confounders (age, gender,

Table 3. ORs for Combined Prior Arrests and Diagnoses by Intent-Specific Firearm Injury

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 models			
Alcohol			
No alcohol-related diagnoses[a]	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)**
Cannabis			
No cannabis-related diagnoses[a]	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)**
Other substance			
No other substance-related diagnoses[a]	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 models			
Depression/anxiety			
No depression/anxiety diagnoses[a]	ref	ref	ref
Depression/anxiety 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)**
Psychosis			
No psychosis-related diagnoses[a]	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)**
Impulse/conduct			
No impulse/conduct-related diagnoses[a]	ref	ref	ref
Impulse/conduct-related diagnoses	1.15 (0.10, 12.88)	– (0.00, ∞)	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)**

Note: Boldface indicates statistical significance ($p<0.05$). All ORs were obtained from multinomial logistic regression models in which the unintentional MVC passenger injury served as the control group.
[a]Includes those with other types of diagnoses.
MVC, motor vehicle collision.

and race).[26,35–40] Each exposure diagnosis was then modeled together with arrest history. Sensitivity analyses were conducted to explore potential confounding by (1) age (restricting to subjects ≥18 years, using restricted cubic splines with three knots, and stratifying [subjects 20–39 and ≥40 years]); (2) SES (adjusting for insurance payer among subjects with a hospital record); and (3) neighborhood disadvantage (residence in ZIP codes in the highest quartile of unemployment, and in the lowest quartile for median household income). Analyses involving residential characteristics were clustered by ZIP code (results are available online in the Appendix or by request). Presented ORs are interpreted as conditional, representing the relative odds of being exposed conditional on being in a specific case group or the control group. For example, the OR for prior alcohol use diagnosis and self-inflicted firearm injury is the odds of an alcohol use diagnosis for the self-inflicted group

(relative to controls) conditional on having sustained either a self-inflicted firearm or MVC passenger injury. Probabilistic linkages were done using The Link King. Statistical analyses were done using Stata, version 14. Linkage and analyses were conducted in 2017–2018.

RESULTS

A total of 763 firearm and 335 MVC passenger injuries met inclusion criteria (Table 1). A majority of firearm injuries were assault-related (58.1%), followed by self-inflicted (28.6%); unintentional (9.3%); and LI (4.1%). A majority of firearm injuries were sustained by males, but intent groups varied in age, race, insurance status, and injury severity.

Prior arrest was more common than hospitalization (for any cause) among all groups except the self-inflicted (Table 1). Arrests were most common in the assault-related (48.5%) and LI groups (48.4%). Prior hospitalization was most common in the self-inflicted group (25.2%). No unintentional firearm-injured individuals were hospitalized in the 2 years prior to injury.

Among individuals with prior arrests, assault-related and unintentional firearm injury cases had the highest median number of arrests (Table 1, Appendix Figure 1A, available online). A majority of arrested individuals in the assault-related, unintentional, and LI firearm injury groups had a felony arrest record (Table 1). Among people who had been both arrested and hospitalized, LI injury cases had the greatest median ratio of hospitalizations to arrests (four hospitalizations/arrest). Timelines of 2-year hospitalization and arrest history for a random subsample of 25 individuals per injury group (Figure 1) show each individual's timeline as a separate row, highlighting the varying proportion in each group hospitalized or arrested and the relative frequency of each type of hospitalization or arrest.

Among people with a prior hospitalization, the LI group had the greatest median number of hospitalizations (Appendix Figure 1B, available online), shortest period between last hospitalization and injury (Table 1), and greatest median number of hospital facilities visited. A majority of previously hospitalized LI cases had comorbid substance use and mental disorder diagnoses (66.7%). A majority of previously hospitalized individuals in the self-inflicted group had a mental disorder diagnosis (63.6%; Table 1).

Assault-related firearm injury cases were more likely than controls to have a prior felony arrest (OR=4.4, 95% CI=2.4, 8.1; Table 2). Assault-related firearm injury cases did not differ significantly from controls in prior substance-related or mental disorder diagnoses. The greater odds of felony arrest history for assault-related firearm injury cases did not materially change when prior diagnoses and arrests were modeled together (Table 3).

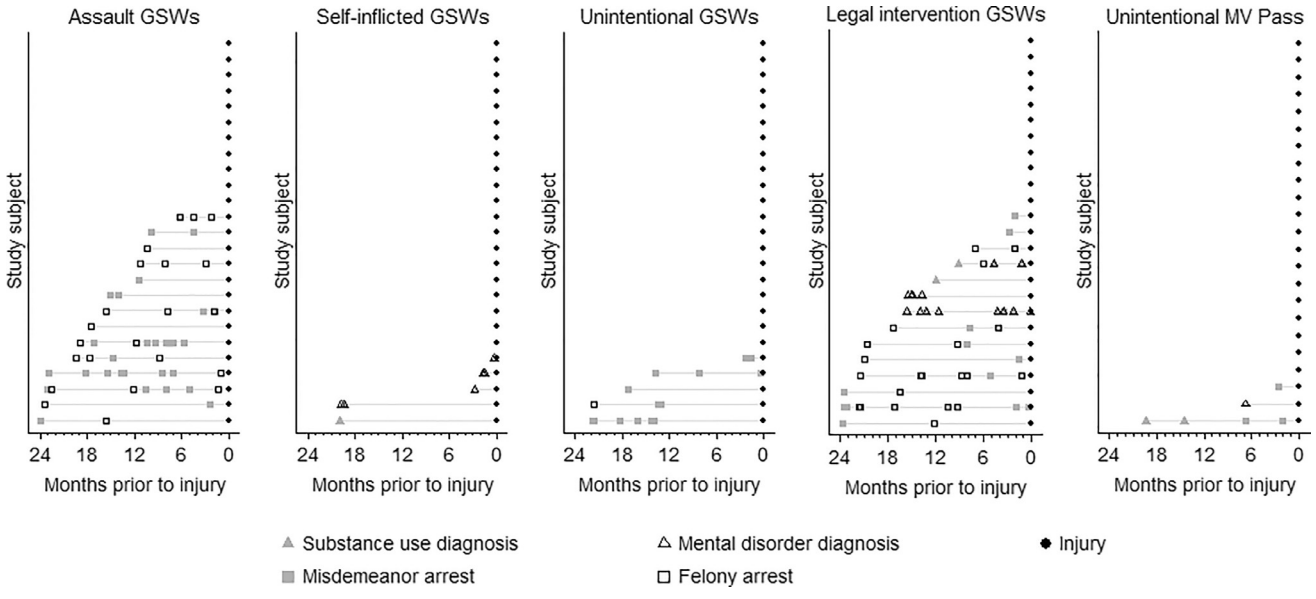

Figure 1. Timeline of arrests, substance use, and mental disorder diagnoses in 2 years prior to injury, by injury intent and mechanism.

Note: 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.

GSW, gunshot wound; MV, motor vehicle.

Self-inflicted firearm injury cases did not differ significantly from controls in their arrest or substance-related diagnosis histories. The self-inflicted firearm injury group had greater odds of depression/anxiety diagnoses (OR=2.9, 95% CI=1.2, 6.7) compared with controls (Table 2). Results were similar (OR=2.9, 95% CI=1.2, 6.9) when prior diagnoses and arrests were modeled together (Table 3).

Unintentional firearm injury cases were no more likely than controls to have a prior misdemeanor or felony arrest (Table 2). These individuals were not included in analyses of prior diagnoses because none had a prior hospitalization.

LI firearm injury cases were 7.4 times more likely to have a felony record than controls (95% CI=2.6, 21.0; Table 2). LI cases were more likely than controls to have a diagnosis related to alcohol use (OR=4.1, 95% CI=1.0, 15.8); cannabis use (OR=11.0, 95% CI=1.0, 119.4); or depression/anxiety (OR=7.2, 95% CI=1.9, 27.7). LI firearm injury cases 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).

When prior diagnoses and arrests were modeled together, LI firearm injury cases were still more likely than controls to have a felony arrest history (Table 3) and cannabis-related, depression/anxiety, or psychosis diagnosis. The greater odds of an alcohol-related or conduct-related diagnosis remained strong but imprecise.

DISCUSSION

Significant differences in prior 2-year history of arrest, substance use, and mental disorder diagnoses were identified among intent-specific firearm injury groups and injured motor vehicle passengers. Assault-related or LI firearm injury cases were more likely than controls to have a prior felony arrest, regardless of substance use or mental disorder diagnoses. The magnitude of the association between LI firearm injury and prior felony arrest was nearly twice that of assault-related firearm injury. LI firearm injury was also associated with prior diagnoses related to cannabis use, psychoses, conduct disorder, and depression/anxiety after accounting for arrest history.

LI firearm injury cases stood out from other individuals in their associations with multiple substance use and mental disorder diagnoses and increased contact with both police and hospitals. In their arrest history, LI injury cases resemble assault-related injury cases. In prior diagnoses, they resemble self-inflicted injury cases. LI firearm injury cases were seen by medical professionals more frequently, in more locations, and more recently than subjects with other injuries. The strongest, albeit imprecise, association was with conduct-related disorders. These results are consistent with findings from the Seattle Police Department,[41] other law enforcement agencies,[42] and researchers elsewhere in the U.S.[17,43] who have also identified an increased risk of LI injury for individuals with a mental disorder or under the influence of drugs or alcohol.

By combining data from the regional trauma center and statewide death certificates, the case groups include nearly every individual shot in Seattle, including those who only received care in the emergency department and those who died without medical treatment. HMC treats the overwhelming majority of all firearm injuries in Seattle, reducing concern that a small sample may be unrepresentative of a larger population. Using exposure data from all of Washington State and probabilistic methods to link across data sources reduces potential misclassification. More specific risk markers were identified by disaggregating substance use and mental disorders into narrower categories. Because of the sole use of administrative data, these methods are likely replicable elsewhere, although results may not be generalizable to communities with different policing or diagnostic practices. Characteristics of intent-specific firearm injury groups may vary geographically. A larger sample of unintentional firearm injuries may reveal statistically significant associations not found in this study. LI firearm injuries are also likely to vary based on the types of confrontations between police and other individuals.

Patterns of prior arrest and hospitalization identified by this study can inform intent-specific firearm injury prevention programs. The greater frequency of arrests relative to hospitalizations in the firearm assault injury group suggests that opportunities for intervention in this group present while individuals are in custody, not just when they are in the hospital. In Canada, the End Gang Life program uses direct messaging around the risk of violent injury and death associated with involvement in gang activities to discourage criminal involvement and encourage gang-involved individuals to exit.[44] In Seattle, several programs currently use contact with law enforcement as a setting for intervention with youths, including The 180 Program, Center for Children and Youth Justice, and Alive and Free.[45,46] Screening instruments for mental disorders or risk of firearm violence, like the SaFETy Score (Serious fighting, Friend weapon carrying, community Environment, and firearm Threats),[47] can be validated and potentially adapted for use in multiple settings, including by law enforcement. Post-screening treatment must be made available, with continuity of care during hospitalization, incarceration, and afterward.

Coordination between police 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 professionals, 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.[15,48,49] Evaluation of the Seattle Police Department's Crisis Response Teams suggests a reduction in repeated confrontations between police and individuals in crisis, and a corresponding increase in referrals for substance use and mental health treatment.[50]

Findings should be interpreted as providing information on non-causal markers of increased risk, rather than causal risk factors. Although results were robust to a variety of sensitivity analyses, including possible confounding by age; SES (measured by insurance payer among individuals with a hospital record); and neighborhood disadvantage (measured by residence in ZIP codes in the highest quartile of unemployment, and in the lowest quartile for median household income); fundamentally the case groups may not be exchangeable with the MVC passenger control group. Alternatively, there may be underlying similarities between cases and controls that have attenuated some of the estimates. Arrest and hospitalization records only document contacts with police and health care that reach a certain threshold of severity. Arrests are not representative of all encounters with police, and Washington State Identification System does not capture criminal behavior or contacts with police not leading to arrest. CHARS only records hospitalizations and does not identify substance use or mental disorders that are untreated or treated elsewhere. Neither system includes data from outside Washington State. Individuals whose contact with police or healthcare professionals was not documented via arrest or hospital diagnosis were treated as "unexposed," which could lead to an underestimation of the strength of associations between exposures and intent-specific injury risk. As an example, substance use disorder diagnoses were not significantly different between assault-related or self-inflicted firearm injury groups and controls; although substance use is a known risk factor for both types of firearm injuries.[6,8,9] Substance use, or exposure to the environment in which substance use occurs, can increase risk of injury but does not necessarily result in a diagnosed disorder during a hospitalization. However, all hospital diagnoses (and not just primary diagnoses) were included, capturing diagnoses that were secondary to an injury or illness. The 2-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. The study population was small, and hospitalization was a rare event, which limited statistical power, including the ability to investigate how racial disparities in the criminal justice system and in access to health care may impact risk of firearm injury. Several estimated ORs were large, with wide CIs that included the null. It was not possible to increase statistical power by lengthening the study period or the exposure window because of limited availability of identifiable data. Substance use and mental disorder diagnoses could not be modeled together because of the high proportion of comorbid diagnoses.

CONCLUSIONS

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 in one setting. The results quantify how differing patterns of prior arrest, substance use, and mental disorders are associated with risk of subsequent intent-specific firearm injury. In particular, they highlight a potential role for medical professionals in preventing LI injuries, as they may be more likely than police officers to encounter these vulnerable individuals prior to their injury. Many firearm injuries occur after a series of encounters with institutions that are meant to help individuals during crises but can fail to provide longer-term solutions.

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BM and ARR, with input from all authors developed the study design. BM was responsible for data acquisition and analysis. All authors contributed to the data interpretation. BM and all authors contributed to and approved the final manuscript.

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SUPPLEMENTAL MATERIAL

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