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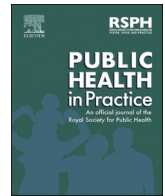
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Firearm injury among people experiencing homelessness: Cross-sectional evidence from a national survey of United States emergency departments

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ABSTRACT

Objectives: Persons experiencing homelessness (PEH) are at high risk for violent victimization. This study leverages unique data from a national study in the United States of America to provide estimates of non-fatal firearm injury among PEH and to describe the contexts related to injury, such as substance use, intent of the injury, and precipitating interpersonal factors.

Study design: Cross-sectional.

Methods: Data from the 1993–2020 National Electronic Injury Surveillance System-Firearm Injury Surveillance Study (NEISS-FISS) were used to describe the context and characteristics of non-fatal firearm injury among PEH aged 16 years or older. Homeless status and substance use data were extracted from a de-identified narrative field. Estimates were weighted to account for the NEISS-FISS complex sampling design.

Results: Probable homelessness was identified in 0.10% of cases ($n = 3,225$). Substance use was documented in 22.73% of cases. Assault comprised 82.64% of injuries. Patients were mostly male (81.38%). Missing data were common on contextual variables: verbal argument (64.62%), physical fight (54.48%) or other criminal activity (62.33%).

Conclusions: Assault is a leading cause of non-fatal firearm injury for PEH and is greater than rates of assault in non-fatal firearm injuries in the general population. Substance use was documented in nearly one quarter of patients, although this is less than expected given prior evidence. Reliance on narrative fields for key variables likely underestimates rates of PEH and substance use.

What this study adds

- This study investigates the contexts of non-fatal firearm-related injuries among persons experiencing homelessness (PEH)
- Assault comprised the majority of non-fatal firearm injuries among PEH
- Surveillance data on PEH is limited by the hidden nature of the population and variability in documenting housing status

1. Introduction

Traumatic injury and violent victimization are prevalent among people experiencing homelessness (PEH) [1]. Although previous

research indicates PEH are at higher risk of violent victimization by knives or blunt objects relative to firearms, firearms are a major source of injury among PEH [2,3]. For instance, firearms were the mechanism of injury in 21.6% of suicides and in 48.0% of homicides among PEH who suffered violent deaths in the United States (US) from 2016 to 2018 [4]. Although, less research has identified the characteristics and contexts of *non-fatal* firearm-related injuries for PEH in the US, PEH are at higher risk for recurrent injury and death relative to housed survivors of violence [3]. Relative to housed survivors of violence in the US, PEH have higher rates of behavioral health comorbidities and higher rates of testing positive for substances in the ED, particularly for alcohol and other substances [1,3]. The circumstances of non-fatal firearm injuries are important to identify, as these injuries may contribute to enduring

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physical or behavioral health difficulties. Substance use is one important factor to explore, as patients with substance use problems may face increased risk of repeated victimization owing to risky situational influences [2]. As substance use is elevated among PEH and is associated with both self-directed and assault-related firearm victimization, research is needed to understand the prevalence of substance use among PEH who are injured by firearms [5,6]. Given this backdrop, the present investigation leverages unique data from a national study to provide estimates of non-fatal victimization and its situational context to inform public health promotion and prevention programming, such as the implementation of hospital-based violence intervention programs [7].

2. Methods

Cross-sectional data from the public-use 1993–2020 National Electronic Injury Surveillance System-Firearm Injury Surveillance Study (NEISS-FISS) were used to understand the context and characteristics of non-fatal firearm injury among PEH aged 16 years or older in the US [8]. The NEISS-FISS is a stratified, probability sample of approximately 100 hospitals with at least six beds and providing 24-hour emergency services and documents injuries where a firearm or gun is mentioned in any way in the ED record.

Homeless status was derived from information contained in a de-identified narrative field that documents the circumstances of the injury. A list of search terms was generated a priori to identify potential cases of homelessness, inclusive of staying in places not meant for human habitation or facing imminent loss of housing due to eviction or fleeing domestic or interpersonal violence. Potentially positive cases were reviewed to identify additional search terms and to rule out potential false positives. This keyword search method is common for identifying relevant cases in other datasets documenting violent victimization, such as the National Violent Deaths Reporting System.

The NEISS-FISS coders are asked to review available ED records and document whether the incident involved “the use, sale, manufacture, or distribution of illicit drugs (for example, opioids, amphetamines, or cocaine)?”. This variable, “drugs,” is coded as “yes,” “no,” or “not stated,” and thus does not specify what substances were present. Therefore, details related to substance use were extracted from narratives to identify whether the patient had any documented substance use. The researcher-generated substance use variable is distinct from the given “drugs” variable in the following two ways: first, it is not limited to illicit substances; furthermore, it focuses on whether the patient had been assessed positive for substances and therefore excludes injuries which are drug-related but did not document that the person was intoxicated or testing positive for substances (such as an injury during the sale of illicit substances).

Sociodemographic characteristics and contextual factors related to firearm injury among PEH were summarized, such as firearm type, intent of the injury, location of the incident, body part injured, and whether the incident involved a physical fight, verbal argument, or any other criminal activity. Estimates were weighted to account for the complex sampling design of the NEISS-FISS.

3. Results

Probable homelessness was identified in a weighted count of 3,225 cases (0.10%). Of 164 unweighted cases initially flagged for possible homelessness using the search terms, 117 were considered likely homeless after review of the narrative field. The search string “homeless” yielded 81 initial results (of which 77 identified the victim as a PEH), with additional search terms accounting for 34.2% of cases of likely PEH.

Whereas the given drug use variable identified 7.84% (95CI: 4.60, 13.06) of cases involving PEH as drug-related, substance use was documented in the narrative field for 22.73% (95CI: 14.33, 34.09) of injuries involving PEH. Polysubstance use was documented in 11.05%

(95CI: 2.65, 36.19) of all cases with any documented substance use. Unweighted counts for documented substances include alcohol (n = 14), methamphetamine and other stimulants (n = 9), cannabis (n = 3), unspecified intoxication (n = 2), and opioids (n = 1).

Characteristics of firearm injuries for PEH are presented in Table 1. Assault comprised 82.64% (95CI: 69.71, 90.77) of cases. Injuries were most often inflicted by gunshot wound (67.75%, 95CI: 51.27, 80.75) but non-gunshot-related injuries (e.g., pistol whipping, injured by ricochet, recoil-related injury; 20.51% (9.77, 38.08)) and bb/pellet gunshot wounds (11.73%, 95CI: 6.74, 19.65) were also common. Although the person who caused the injury was unknown in 51.05% of cases (95CI: 39.57, 62.46), strangers were often identified as having caused the injury (30.91%, 95CI: 23.92, 38.91). Over half of injuries occurred in public settings (57.92%, 95CI: 42.60, 71.86). Ambulance was the most common mode of transportation to the ED (69.64%, 95CI: 60.09, 77.76). Most injuries were either to the legs/feet (29.09%, 95CI: 21.11, 38.60) or head/neck (27.10%, 95CI: 15.59, 42.80). Half of the injuries resulted in hospitalization (50.82%, 95CI: 37.30, 64.23). Detail related to the context of the injury were lacking, as most cases had missing data on the given drug use (68.06%, 95CI: 56.20, 77.97), verbal argument (64.62%, 51.65, 75.74), physical fight (54.48%, 95CI: 43.45, 65.08), or other criminal activity (62.33%, 95CI: 49.22, 73.85) variables.

Patients were mostly male (81.38%, 95CI: 71.56, 88.36). Race was unavailable in 19.26% of cases (10.91, 31.72). There were similar proportions of black (30.05%, 95CI: 18.65, 44.60) and white (32.62%, 95CI: 24.84, 41.50) patients, followed by all other races (18.08%, 95CI: 9.85, 30.83). An estimated 13.18% (95CI: 7.52, 22.08) of patients were Hispanic. Age was distributed as 16–24 (14.29%, 95CI: 7.94, 24.39), 25–34 (25.15, 95CI: 16.30, 36.70), 35–44 (28.09, 95CI: 17.97, 41.06), 45–54 (23.50, 95CI: 15.27, 34.37), and 55 or older (8.96%, 95CI: 5.02, 15.49).

4. Discussion

The present study found that assault is the leading cause of non-fatal firearm injuries for PEH, accounting for nearly four-fifths of injuries. In other nationwide surveys of non-fatal firearm-related injuries of the general population, assault comprises approximately 40% of ED visits [9]. Similar to other epidemiologic surveys of non-fatal firearm-related injury, self-harm accounted for a lower proportion of visits, as intentional, self-directed gunshot wounds have high fatality rates [10].

Although substance use was documented in approximately one-quarter of patients, it is somewhat less than expected given findings from other ED-based studies [1,3]. There is a possibility that substance use was not consistently screened or documented across EDs. Systematic review evidence of substance use has found a pooled prevalence of 34.9% for alcohol in firearm injuries and 39%–50% for drugs other than alcohol [11]. In the present study, the available qualitative data indicated that alcohol and stimulants, particularly methamphetamine, were most often documented among PEH injured by firearms. Both alcohol use and methamphetamine are risk factors for both violence perpetration and violent victimization [12]. Survivors of firearm injuries have been found to have higher rates of SUD prior to injury and increased rates of SUD 12 months following the injury [13]. Given that SUD and violence (both self-directed and other-directed) may share reciprocal relationships, longitudinal studies would be particularly useful in disentangling the trajectories of housing status, substance use, and injury among PEH.

The use of the NEISS-FISS to study firearm injury among PEH is novel. Surveillance data can help to estimate the tripartite relationship between homelessness, firearm violence, and substance use, which may be characterized as syndemic, interactive phenomena that could share an underlying causal structure. Future research may leverage artificial intelligence approaches with the NEISS-FISS, such as natural language processing, to aid in the efficient extraction of relevant textual data related to the circumstances of the injury. Longitudinal studies of PEH

Table 1
Characteristics of firearm-related injuries for people experiencing homelessness.

	Total N = 3,225		No Substance Use N = 2,492 (77.27 %)	Substance Use N = 733 (22.73%)
Intent	N	% (95CI)	% (95CI)	% (95CI)
Unknown	172	5.33 (1.85, 14.41)	6.90 (2.26, 19.18)	0.00
Unintentional	156	7.63 (3.60, 15.42)	6.26 (2.83, 13.30)	12.28 (4.85, 27.75)
Assault	2665	82.64 (69.71, 90.77)	81.14 (67.00, 90.12)	87.72 (72.25, 95.15)
Self-Harm	107	3.32 (1.49, 7.20)	4.29 (1.75, 10.14)	0.00
Law Enforcement	35	1.09 (0.24, 4.86)	1.40 (0.31, 6.09)	0.00
Who Caused the Injury				
Unknown	1647	51.07 (39.57, 62.46)	48.88 (36.14, 61.76)	58.53 (39.38, 75.40)
Self	165	5.12 (2.63, 9.71)	6.62 (3.24, 13.06)	0.00
Known Contact	239	7.41 (2.48, 20.15)	8.87 (2.98, 23.56)	2.46 (0.26, 19.32)
Stranger	997	30.91 (23.92, 38.91)	29.13 (21.68, 37.91)	36.97 (19.42, 58.81)
Other/Did not see	177	5.49 (2.70, 10.83)	6.50 (3.12, 13.05)	2.05 (0.24, 15.40)
Firearm Type				
Unknown	1857	57.58 (43.87, 70.22)	55.06 (40.20, 69.06)	66.17 (47.20, 81.06)
Handgun	822	25.49 (15.32, 39.27)	31.74 (20.47, 45.66)	4.23 (0.82, 19.09)
Rifle	29	0.90 (0.25, 3.14)	1.16 (0.34, 3.94)	0.00
Shotgun	143	4.43 (1.43, 12.90)	3.05 (0.42, 19.09)	9.14 (2.73, 26.50)
BB gun	374	11.60 (6.66, 19.42)	8.99 (4.82, 16.15)	20.46 (5.46, 53.43)
Incident Location				
Unknown	859	26.64 (15.30, 42.18)	28.49 (14.09, 49.18)	20.33 (13.13, 30.11)
Residential Location	377	11.69 (3.83, 30.56)	15.13 (5.23, 36.10)	0.00
Public Setting	1868	57.92 (42.60, 71.86)	54.21 (37.24, 70.26)	70.53 (54.46, 82.73)
Other Setting	121	3.75 (1.79, 7.69)	2.17 (0.72, 6.37)	9.14 (2.73, 26.50)
Firearm-related GSW	2160	67.75 (51.27, 80.75)	64.85 (48.24, 78.50)	77.49 (44.56, 93.65)
Firearm-related non-GSW	654	20.51 (9.77, 38.08)	26.03 (13.20, 44.87)	2.05 (0.24, 15.40)
BB/Pellet GSW	374	11.73 (6.74, 19.65)	9.12 (4.92, 16.30)	20.46 (5.46, 53.43)
Body Part				
Unknown/Other	49	1.52 (0.50, 4.5)	1.36 (0.37, 4.94)	2.05 (0.24, 15.40)
Head/neck	874	27.10 (15.59, 42.80)	30.42 (18.73, 45.33)	15.83 (3.47, 49.55)
Upper Trunk	358	11.10 (4.75, 23.82)	11.96 (5.11, 25.50)	8.19 (1.66, 32.05)
Lower Trunk	582	18.05 (8.20, 35.18)	15.17 (8.19, 26.39)	27.83 (8.42, 61.80)

Table 1 (continued)

	Total N = 3,225		No Substance Use N = 2,492 (77.27 %)	Substance Use N = 733 (22.73%)
Arm/Hand	424	13.15 (7.98, 20.89)	12.56 (7.61, 20.04)	15.14 (7.85, 27.20)
Leg/Foot	938	29.09 (21.11, 38.60)	28.53 (18.92, 40.59)	30.97 (17.56, 48.57)
Method of Transport to ED				
Not stated/Other	248	7.69 (3.84, 14.81)	9.31 (3.82, 20.95)	2.18 (0.31, 13.73)
EMS/Ambulance	2246	69.64 (60.09, 77.76)	68.82 (57.12, 78.53)	72.44 (51.00, 86.91)
Private Vehicle	237	7.35 (2.94, 17.19)	0.65 (1.60, 22.94)	10.23 (3.04, 29.32)
Walk-in	286	8.87 (3.67, 19.93)	10.03 (4.18, 22.18)	4.91 (0.92, 22.26)
Police	208	6.45 (2.74, 14.42)	5.34 (1.41, 18.20)	10.23 (3.04, 29.32)
Disposition				
Treated and released	1456	45.15 (33.09, 57.80)	43.90 (29.66, 59.22)	49.39 (37.78, 61.06)
Hospitalized	1639	50.82 (37.30, 64.23)	52.09 (36.86, 66.94)	46.52 (33.34, 60.20)
Other	130	4.03 (1.65, 9.53)	4.01 (1.57, 9.89)	4.09 (0.77, 18.94)
Fight	283	8.78 (3.45, 20.59)	10.75 (4.46, 23.74)	2.05 (0.22, 16.55)
Crime	399	12.37 (6.83, 21.38)	14.61 (8.23, 24.60)	4.77 (1.01, 19.77)
Argument	315	9.77 (3.93, 22.28)	10.31 (4.04, 23.89)	7.91 (1.45, 33.44)

would be particularly valuable for identifying the potentially interactive relationships between housing status, substance use, and firearm injury.

However, this study reveals difficulties in using the NEISS-FISS to generate reliable estimates of the impact of firearm injury on PEH, especially given the large amounts of missing data on circumstances related to the injury such as physical fights, verbal arguments, or other criminal incidents. Limitations include reliance on narrative fields to document housing status and substance use, which may substantially underestimate the number of PEH presenting to the ED with firearm-related injuries. Further, the data does not permit a full rendering of covariates or making causal determinations. Despite these limitations, present study findings provide insight into the use of the NEISS-FISS to identify the circumstances of firearm-injury for this hidden and hard-to-reach population.

Author statement

The IRB of Washington University School of Medicine in St. Louis determined that the study did not meet criteria for human subjects research and that ethical review was not required. This work represents the authors' independent research conducted with support by the National Institute on Alcohol Abuse and Alcoholism (5K01AA026645; Dr. Christopher P. Salas-Wright).

Conflicts of interests

Dr. Dell is a consultant for Places for People, Inc. The authors declare no conflicts of interests.

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