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Characterising fire or burn-related fatalities in the USA using the National Violent Death Reporting System, 2003–2020

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ABSTRACT

Objectives Intentional fire or burn-related deaths are rare in the USA compared with some countries, but do occur, and our knowledge of their epidemiology is limited. The objective of this study is to epidemiologically describe fire or burn-related deaths resulting from violence, including victim and suspected perpetrator characteristics and incident circumstances.

Methods This cross-sectional study uses National Violent Death Reporting System data from 2003 to 2020 to examine violent fire or burn-related deaths among individuals of all ages. Analyses include the following case types: (1) fire or burn-related injuries were immediate, underlying or antecedent cause of death; (2) death resulted from arson; or (3) weapon used was categorised as 'fire or burns'. Precipitating circumstances were examined by manner of death (ie, suicide, homicide or undetermined intent) using χ^2 tests, with p values of <0.05 indicating statistical significance.

Results Among 4395 victims, most were male (64.6%), non-Hispanic white (60.8%) and 20–64 years (72.7%). Deaths by suicide were most common (38.9%), followed by homicides (32.6%) and undetermined deaths (28.5%). Current mental health (53.4%) and substance use problems (15.0%) were common among suicide deaths. One-half (49.8%) of homicide deaths were precipitated by another crime and 19.5% were related to intimate partner violence.

Conclusions The prevalence of mental health and substance use problems among suicide victims underscores the urgency for targeted prevention strategies and timely interventions. Stressors, such as interpersonal conflicts and financial problems, may contribute to fire or burn-related violent deaths.

INTRODUCTION

Burns have been a leading cause of death in the USA for many years. In 2021, an estimated 3788 people died from fire or burn-related injuries in the USA, most of which were unintentional.¹ Advancements in fire prevention, such as improved building codes and better treatments for burn-related injuries, decreased the rate of unintentional fire or burn-related deaths nearly 25% from 2001 to 2021, from 1.21 to 0.91 per 100 000 US population, respectively.^{1,2}

Intentional burn-related injuries and deaths are much rarer in the USA than in some countries, such as India, but they do occur.³ Approximately one individual dies each day in the USA due to violent fire or burn-related causes and the fatality rate has changed little over the past two decades (0.10 vs 0.09 per

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Burns are a common cause of morbidity and mortality globally. While intentional fire or burn-related deaths are much rarer in the USA than in some countries, they do occur; however, little is known about their epidemiology.

WHAT THIS STUDY ADDS

⇒ This study uses multistate US data to investigate fire or burn-related deaths resulting from violence, an important topic that is rarely studied in the USA.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study provides valuable information about the characteristics and circumstances of fire and burn-related deaths that can inform prevention efforts and also identifies areas for future research.

100 000 US population in 2001 and 2021, respectively).¹ Most violent fire or burn-related fatalities are classified as self-inflicted burns or self-immolation and these methods are used in less than 1% of attempted suicides.^{3–8} However, not all intentional burns are self-inflicted. It is estimated that 1.5%–2.2% of burn centre admissions in the USA are attributable to assault or abuse by another person.^{7,9,10}

Intentionally inflicted burn-related injuries are associated with greater likelihood of mortality and worse non-fatal outcomes compared with injuries from unintentional burns.^{7,9} Risk factors for burn-related injuries include age, gender, race, socio-economic status, disability status, mental health concerns, and history of abuse or interpersonal violence.^{4,7,11} Due to the wide variety of risk factors and limited research on this topic, it is challenging to identify which predictive factors are most relevant.

There are limited studies examining fatalities from intentional burns, particularly in the USA. Much of the prior literature focused on one specific population or cause of burn-related injury.^{4,6,8,9} These studies often used data from regional burn centres, the American Burn Association National Burn Repository, or the National Vital Statistics System.^{7–9} These national databases and registries are robust and include characteristics of the patients, injury descriptions and burn mechanisms.^{12,13} However, they are limited in the depth of individual-level data they capture, such as



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injury circumstance information or characteristics of suspected perpetrators.

The National Violent Death Reporting System (NVDRS) provides a unique opportunity to comprehensively assess fatal fire or burn-related injuries using multistate data, allowing us to develop a more nuanced understanding of the circumstances surrounding these deaths. To our knowledge, only one study has used NVDRS data to identify psychosocial determinants of burn-related suicide.⁴ Characterisation of these deaths and the preceding circumstances or risk factors, as well as potential perpetrators involved, may contribute to future prevention and intervention efforts. Our objective was to use the NVDRS to epidemiologically describe fire or burn-related deaths resulting from violence, including victim and suspected perpetrator characteristics and incident circumstances.

METHODS

Data source

This cross-sectional study used data from the NVDRS Restricted Access Database. The NVDRS is a state-based surveillance system that compiles data from multiple sources, including coroner/medical examiner (CME) reports, law enforcement (LE) reports and death certificates, to provide a comprehensive understanding of fatalities due to violence.¹⁴ Details about victims and suspected perpetrators are collected, including demographic information, mental health status, toxicology results and weapons used. Additionally, the NVDRS includes narrative case summaries based on CME and LE reports.

Forty-eight states, the District of Columbia and Puerto Rico reported cases that met our inclusion criteria (Alaska, Maryland, Massachusetts, New Jersey, Oregon, South Carolina and Virginia (2003–2020); Colorado, Georgia, North Carolina, Oklahoma, Rhode Island and Wisconsin (2004–2020); Kentucky, New Mexico and Utah (2005–2020); Ohio (2011–2020); Michigan (2014–2020); Arizona, Connecticut, Hawaii, Kansas, Maine, Minnesota, New Hampshire, New York and Vermont (2015–2020); Illinois, Indiana, Iowa, Pennsylvania and Washington (2016–2020); California, Delaware, Nevada, West Virginia, the District of Columbia and Puerto Rico (2017–2020); Alabama, Louisiana, Missouri and Nebraska (2018–2020); Montana, North Dakota and Wyoming (2019–2020); Mississippi, Tennessee, Arkansas, Texas and Idaho (2020)). Hawaii was excluded from years 2017, 2018, 2020, and New York from 2019 due to incomplete reporting. Illinois, Pennsylvania and Washington collected data on >80% of violent deaths in 2016 and 2017, per their funding requirements. In 2018 and 2019, Washington provided data for all violent deaths, and Illinois and Pennsylvania submitted data for ≥80% of violent deaths. California reported data from 4, 21, 30 and 35 counties in 2017, 2018, 2019 and 2020, respectively, and Texas reported data from 4 counties in 2020, per funding requirements.

Case selection criteria

NVDRS data were obtained from the Centers for Disease Control and Prevention for fatalities occurring from 1 January 2003 to 31 December 2020 among people of all ages who had an NVDRS abstractor-coded manner of death of suicide, homicide or undetermined intent. To identify fire or burn-related deaths, we conducted a multistep case selection process (figure 1).

First, we used International Classification of Diseases, 10th Revision (ICD-10) codes for underlying and contributory causes of death: T20–T32 (burns and corrosions); X76

(intentional self-harm by smoke, fire and flames); X97 (assault by smoke, fire and flames); and Y26 (exposure to smoke, fire and flames, undetermined intent) and ICD-9-CM diagnostic codes 940–949 (burns) for cause of fatal injury. Second, we queried NVDRS abstractor-coded ‘nature of other precipitating crime’ variables for responses indicating ‘arson’. Third, we queried NVDRS abstractor-coded ‘weapon type’ variable for responses indicating ‘fire or burns’ were used to inflict fatal injury. Lastly, key search terms were identified by reviewing case narratives from deaths identified as meeting study inclusion criteria in steps 1–3. These search terms were applied to cause of death text variables. Collectively, these steps identified 4686 potential cases. Cases identified as fire or burn-related based on keyword searches or nature of crime variables indicating ‘arson’, but not identified using ICD-9 codes, ICD-10 codes or weapon type variables (n=520) were further reviewed by a study team member to assess potential misclassification. Subsequently, 405 false-positive cases were removed, including cases involving postmortem burns, carbon monoxide (CO) poisoning from non-fire sources, (eg, motor vehicle exhaust), and asphyxia deaths from strangulation.

Next, we reviewed CME and LE narratives to identify deaths not found using prior strategies (n=485 641). We excluded cases where both CME and LE narratives were unavailable. A study team member reviewed remaining case narratives to identify key search terms indicating fire or burn-related fatalities. To help eliminate false positives, cases were excluded if the weapon type was something other than poisoning, unknown or missing. Per NVDRS coding rules, if multiple weapons were used to inflict injury, abstractors only code the weapon causing the fatal injury. However, if the weapon causing fatal injury is undetermined, all weapons contributing to the death are coded. The decision to review narratives for cases with weapon type ‘poisoning’ was guided by the NVDRS coding manual, which instructs that deaths caused by CO poisoning should be classified as ‘poisoning’ for weapon type. If CO from fire contributed to the death, ‘carbon monoxide poisoning’ should be coded as a secondary weapon and ‘fire or burns’ as the primary weapon.¹⁵ We reviewed narratives for these cases to identify potential misclassifications. If the case narrative contained ‘smoke’, ‘soot’, ‘combustion’, ‘asphyxia’ or ‘suffocation’, but the source (eg, fire) could not be identified, the case was excluded. The remaining 1900 case narratives were examined thoroughly and an additional 114 cases were identified as fire or burn-related fatalities. Two study team members separately reviewed a random selection of 10% of the 1900 newly identified cases to ensure accuracy. There were no coding disagreements. In total, 4395 cases were included in study analyses.

Measures

Our analyses used variables describing demographics, incident characteristics, toxicology reports and precipitating circumstances. States where the injury occurred were categorised into US geographic regions (Northeast, Mid-West, West and South).¹⁶ Several variables were recoded, including education level, injury location type, victim–suspect relationship, mental illness diagnosis and another precipitating crime type, primarily to mask small cell sizes (n<10) that could potentially identify decedents. For toxicology results, ‘tested for’ variables were used as denominators to determine the percentage of decedents testing positive for a substance.

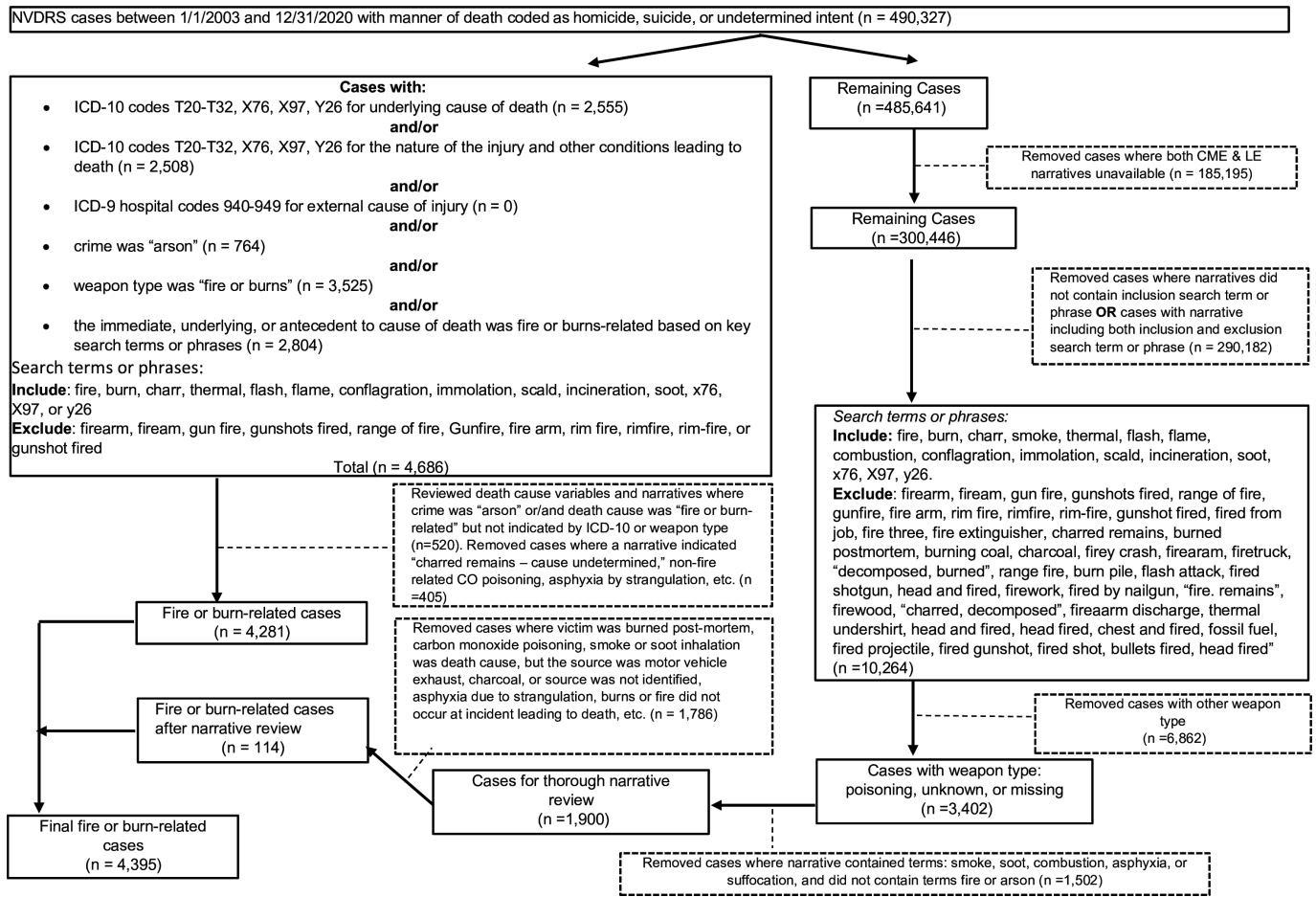


Figure 1 Flow chart depicting case selection process. CME, coroner/medical examiner; ICD-10, International Classification of Diseases, 10th Revision; LE, law enforcement. NVDRS, National Violent Death Reporting System.

Statistical analyses

Distributions are described using frequencies and percentages. Precipitating circumstances were examined by manner of death (ie, suicide, homicide or undetermined intent) using χ^2 tests, with p values of <0.05 indicating statistical significance. All analyses were conducted using SAS V.9.4 (SAS Institute Inc). This study was determined not to be human subjects research by the Institutional Review Board at the authors' institution. Patients and the public were not involved in the design, conduct, reporting or dissemination of this research.

RESULTS

Victim, injury, and death characteristics

Table 1 summarises victim, injury and death characteristics of fire or burn-related fatalities. Of the 4395 fatalities, 38.9% were suicides, 32.6% were homicides, and 28.5% had undetermined intent. Overall, nearly three-quarters (72.7%) of decedents were 20–64 years old, 64.6% were male, 60.8% were racialised as white, non-Hispanic.

There were significant differences in demographic variables among victims who died by suicide, homicide and undetermined intent ($p < 0.0001$). Homicide victims were younger (median: 36; range: 0–97 years) than victims of suicide (median: 48; range: 9–96 years) and undetermined intent (median: 49; range: 0–99 years). The percentage of decedents who were male was greater among suicide deaths (70.9%) compared with homicide deaths (58.4%). However, compared

with female victims, male victims were over-represented for all manners of death ($p < 0.0001$).

Circumstances

Known circumstances were reported for 87.2% of suicide deaths, 74.6% of homicide deaths, and 55.6% of undetermined deaths (table 2). When circumstances were known, having a current mental health problem was significantly more common among victims who died by suicide (53.4%), compared those who died by homicide (5.0%) or undetermined intent (33.6%) ($p < 0.0001$). A significantly higher proportion of individuals who died by suicide had current depressed mood, were ever treated for mental problems, or were currently receiving treatment for mental illness ($p < 0.0001$), compared with those who died by other manners. The most common mental health diagnoses among individuals with a current mental health problem who died by suicide were depression or dysthymia (70.7%), bipolar disorder (20.3%), or schizophrenia (20.1%). Alcohol dependence/alcohol problems (14.9% vs 3.8%) and other substance use problems (15.0% vs 8.3%) were significantly more common among individuals who died by suicide compared with homicide ($p < 0.0001$).

Among 21.3% of victims, death was precipitated by another serious crime, frequently arson (61.4%), assault/homicide (27.9%) or robbery (10.4%). Arguments or conflicts were determined to have led to 14.2% of deaths. The percentage of deaths resulting from argument or conflict differed significantly by

Table 1 Characteristics of fire or burns victims, injuries and deaths among all ages in the USA, NVDRS, 2003–2020 (n=4395)

Characteristics	Victims, No (%)			
	Overall	Suicide	Homicide	Undetermined
Total	4395 (100.0)	1708 (38.9)	1433 (32.6)	1254 (28.5)
Person type				
Victim	4328 (98.5)	1649 (96.6)	*	*
Both victim and suspect†	67 (1.5)	59 (3.5)	*	*
Age group, years				
Under 5	218 (5.0)	0 (0.0)	159 (11.2)	59 (4.7)
5–19	317 (7.2)	50 (2.9)	173 (12.1)	94 (7.5)
20–44	1593 (36.4)	686 (40.2)	538 (37.8)	369 (29.6)
45–64	1591 (36.3)	749 (43.9)	387 (27.2)	455 (36.5)
65 and over	659 (15.1)	221 (13.0)	168 (11.8)	270 (21.7)
Unknown/missing (n=17)‡				
Sex				
Male	2839 (64.6)	1211 (70.9)	836 (58.4)	792 (63.2)
Female	1553 (35.34)	496 (29.1)	596 (41.6)	461 (36.8)
Unknown/missing (n=3)‡				
Race and ethnicity				
White, non-Hispanic	2668 (60.8)	1216 (71.3)	638 (44.6)	814 (65.0)
Black or African American, non-Hispanic	932 (21.2)	206 (12.1)	482 (33.7)	244 (19.5)
American Indian/Alaska Native, non-Hispanic	95 (2.2)	22 (1.3)	28 (2.0)	45 (3.6)
Asian/Pacific Islander, non-Hispanic	154 (3.5)	92 (5.4)	27 (1.9)	35 (2.8)
Other/unspecified, non-Hispanic	34 (0.8)	*	17 (1.2)	*
Two or more races, non-Hispanic	92 (2.1)	*	40 (2.8)	*
Hispanic, any race	414 (9.4)	133 (7.8)	199 (13.9)	82 (6.6)
Unknown/missing (n=6)‡				
Injury location type				
House, apartment	2983 (71.4)	1008 (62.0)	986 (72.6)	989 (82.9)
Motor vehicle/transportation§	512 (12.3)	291 (17.9)	143 (10.5)	78 (6.5)
Business/commercial area¶	215 (5.1)	83 (5.1)	74 (5.4)	58 (4.9)
Outdoor or recreation area**	214 (5.1)	116 (7.1)	*	*
Public road, street, railroad tracks, bridge††	203 (4.9)	105 (6.5)	72 (5.3)	26 (2.2)
School or institution‡‡	50 (1.2)	23 (1.4)	*	*
Unknown/missing (n=218)‡				
Injury region§§				
South	1586 (37.6)	577 (34.5)	611 (46.0)	398 (32.5)
Mid-West	999 (23.7)	367 (21.9)	310 (23.4)	322 (26.3)
West	826 (19.6)	379 (22.6)	212 (16.0)	235 (19.2)
Northeast	813 (19.3)	351 (21.0)	194 (14.6)	268 (21.9)
Not applicable/unknown/missing (n=171)‡¶¶				

Column percentage may not sum to 100.0% because of rounding error.

* Cell frequency <10, masked.

† The person was both a victim and suspect (ie, the person killed someone else and then died by suicide).

‡ Unknown, missing and not applicable values were omitted from the denominator when calculating percentages.

§ Includes motor vehicle; public transportation or station (eg, bus, train, plane, airport, depot, taxi); and parking lot/public parking garage.

¶ Includes service station; industrial or construction areas (eg, factory, warehouse); office building; bar, nightclub; liquor store; other; hotel/motel; and abandoned house, building or warehouse.

** Includes natural area (eg, field, river, beaches, woods); park, playground, public use area; cemetery, graveyard or other burial ground; sports or athletic area (eg, stadium, baseball field, gymnasium, recreation centre); and farm.

†† Includes street, road, sidewalk, alley; highway, freeway; railroad tracks (ie, other than public transportation or station); bridge.

‡‡ Includes elementary school, middle school (ie, k-8), including school dormitory, residential school; high school, including school dormitory, residential school; unspecified school; supervised residential facility (eg, shelter, halfway house, group home); jail, prison, detention facility; synagogue, church, temple; mosque, shrine, tabernacle, cathedral; and hospital or medical facility.

§§ States are grouped into the US regions: https://www.census.gov/programs-surveys/economic-census/guidance-geographies/levels.html#par_textimage_34.

¶¶ Includes Puerto Rico.

NVDRS, National Violent Death Reporting System.

Table 2 Characteristics and circumstances of fire or burn-related fatalities among all ages in the USA, NVDRS, 2003–2020 (n=3256)

Characteristics	Victims, No. (%)				P value
	Overall	Suicide	Homicide	Undetermined	
Circumstances known, total	3256	1490	1069	697	
Mental health and substance use*					
Current mental health problem	1082 (33.2)	795 (53.4)	53 (5.0)	234 (33.6)	<0.0001
Mental health diagnosis†					
Depression/dysthymia	598 (66.4)	478 (70.7)	16 (38.1)	104 (56.8)	
Bipolar disorder	194 (21.5)	137 (20.3)	12 (28.6)	45 (24.6)	
Schizophrenia	169 (18.8)	136 (20.1)	‡	‡	
Anxiety disorder	142 (15.8)	95 (14.1)	‡	‡	
Other§	172 (19.1)	114 (16.9)	18 (42.9)	40 (21.9)	
Unknown/missing (n=181)¶					
Current depressed mood	547 (16.8)	471 (31.6)	‡	‡	<0.0001
Current treatment for mental illness	565 (17.4)	430 (28.9)	17 (1.6)	118 (16.9)	<0.0001
Ever treated for mental problem	790 (24.3)	603 (40.5)	26 (2.4)	161 (23.1)	<0.0001
Alcohol dependence or alcohol problem	435 (13.4)	222 (14.9)	41 (3.8)	172 (24.7)	<0.0001
Other substance abuse problem**	508 (15.6)	223 (15.0)	89 (8.3)	196 (28.1)	<0.0001
Crime and criminal activity					
Precipitated by another crime††	694 (21.3)	116 (7.8)	532 (49.8)	46 (6.6)	<0.0001
Crime type†,††					
Arson	420 (61.4)	65 (56.0)	331 (63.1)	25 (55.8)	
Assault, homicide	191 (27.9)	58 (50.0)	121 (23.1)	12 (27.9)	
Robbery	71 (10.4)	‡	67 (12.8)	‡	
Burglary	35 (5.1)	‡	32 (6.1)	‡	
Drug trade	30 (4.4)	‡	29 (5.5)	‡	
Rape, sexual assault	29 (4.2)	‡	23 (4.4)	‡	
Other‡‡	66 (9.7)	‡	51 (9.7)	‡	
Unknown/missing (n=10)¶					
Other crime in progress††	458 (66.0)	54 (46.6)	380 (71.4)	24 (52.2)	<0.0001
Gang related§§, ¶¶			52 (4.9)		
Relationship and life stressors					
Argument or conflict led to the victim's death††, ***	462 (14.2)	144 (9.7)	260 (24.3)	58 (8.3)	<0.0001
Family relationship problem†††	240 (7.4)	129 (8.7)	68 (6.4)	43 (6.2)	0.0354
Other relationship problem†††	172 (5.3)	73 (4.9)	48 (4.5)	51 (7.3)	0.0230
Perpetrator of interpersonal violence/past month	116 (3.6)	92 (6.2)	‡	‡	<0.0001
Abuse/neglect led to death§§§	113 (3.5)	‡	93 (8.7)	‡	<0.0001
Victim of interpersonal violence/ past month	49 (1.5)	‡	30 (2.8)	‡	<0.0001
Physical fight (two people)§§§	44 (1.4)	‡	25 (2.3)	‡	0.0030
History of child abuse/neglect¶¶¶	40 (1.2)	‡	24 (2.3)	‡	0.0011
Specific to suicide/undetermined intent					
History of suicide thoughts§§§	465 (21.3)	400 (26.9)		65 (9.3)	<0.0001
History of suicide attempts	513 (23.5)	445 (29.9)		68 (9.8)	<0.0001
Disclosed intent to die by suicide	474 (21.7)	412 (27.7)		62 (8.9)	<0.0001
Intimate partner problem	459 (21.0)	378 (25.4)		81 (11.6)	<0.0001
Physical health problem	308 (14.1)	205 (13.8)		103 (14.8)	0.5231
Financial problem	182 (8.3)	150 (10.1)		32 (4.6)	<0.0001
Job problem	166 (7.6)	141 (9.5)		25 (3.6)	<0.0001
Recent criminal legal problem	153 (7.0)	112 (7.5)		41 (5.9)	0.1626
Other death of friend or family	124 (5.7)	94 (6.3)		30 (4.3)	0.0589
Eviction or loss of home****	100 (4.6)	80 (5.4)		20 (2.9)	0.0091
Civil legal (non-criminal) problems	92 (4.2)	71 (4.8)		21 (3.0)	0.0572
School problem	14 (0.6)	14 (0.9)		0 (0.0)	0.0102
Specific to homicide					
Intimate partner violence related			208 (19.5)		
Drug involvement			109 (10.2)		
Victim was a bystander			57 (5.3)		
Jealousy (lovers triangle)			33 (3.1)		
Random violence††††			22 (2.1)		

Continued

Table 2 Continued

*Prior to the 2009 data year, mental health and substance use circumstances only applied to suicide victims. From the 2009 data year forward, these circumstances can be endorsed for all death types except for unintentional firearm injuries.

†Categories are not mutually exclusive.

‡Cell frequency <10, masked.

§Includes post-traumatic stress disorder, attention deficit/hyperactivity disorder, eating disorder, obsessive-compulsive disorder, autism spectrum (including Asperger's Syndrome), dementia (eg, Alzheimer's disease, Lewy body dementia), other specified in diagnosis text, including personality disorders, etc.

¶Unknown and missing values were omitted from the denominator when calculating percentages.

**As of August 2013, a victim who takes methadone is no longer assumed to be in treatment for heroin addiction and should be coded as 'No' unless other information is available (eg, taking methadone as part of substance abuse treatment).

††Prior to the 2009 data year, this circumstance only applied to homicide and legal intervention victims. From the 2009 data year forward, this circumstance can be endorsed for all death types except for unintentional firearm injuries.

‡‡Includes motor vehicle theft, witness intimidation/elimination, other specified in text.

§§This circumstance applied to homicide and legal intervention victims. Before August 2013, this variable only had two response categories, 'Yes' and 'No, unknown, unavailable'. This variable also included both youth gangs. In August 2013, more response options were added to better define the type of gang activity involved in the incident.

¶¶Gang-related included gang motivated, suspected gang member involvement, gang-related not otherwise specified, or organised crime including motorcycle, mafia and drug cartel.

***This variable was modified in two ways in August 2013. First, the 'other argument' and 'argument over money and property' were combined into a single variable. Second, the previous prohibition not to use this code when 'intimate partner violence' and 'jealousy between intimate partners' are coded has been removed. Code based on the guidance above regardless of other circumstances checked.

†††This variable was added in August 2013 and replaces family stressor, which was added in 2009.

††††Prior to the 2009 data year, this circumstance only applied to suicide victims. From the 2009 data year forward, this circumstance can be endorsed for all death types except for unintentional firearm injuries. Before August 2013, this included any relationship except intimate partners. After August 2013, this includes any relationship except intimate partner or family relationships.

§§§Variable added in 2013.

¶¶¶ Before August 2013, this variable was used to collect deaths related to abuse and deaths related to intimate partner violence that had a history of abuse. As of August 2013, this variable captures any history of abuse as a child outside the fatal incident.

****Variable added in 2009.

†††††Prior to 2009, this variable was only available as a choice in a drop down for 'other homicide circumstance'. In 2009, this variable was pulled out as its own circumstance.

NVDRS, National Violent Death Reporting System.

manner of death: suicide (9.7%), homicide (24.3%) and undetermined intent (8.3%; $p < 0.0001$).

Among individuals who died by suicide, 26.9% had a known history of suicidal thoughts or plans, 29.9% had a history of prior suicide attempt(s) and 27.7% disclosed to another person their intent to die by suicide within the past month. Intimate partner problems contributed to 25.4% of suicide deaths.

Among individuals who died by homicide, deaths were often related to an immediate or ongoing conflict or violence between current or former intimate partners (19.5%). Although information on child maltreatment was not collected for all deaths, when available, nearly one-third (32.8%, $n = 84$

cases) of homicide deaths among children 0–19 years were attributable to abuse or neglect by a caregiver, and for 7.8% ($n = 20$) of children, the child had a history of child abuse or neglect by a caregiver.

Toxicology

One-third (32.5%) of decedents who were tested had a toxicology report indicating presence of alcohol (table 3). Additionally, 89.2% of decedents tested positive for CO, 22.3% for opiates, 20.7% for benzodiazepines, 18.3% for marijuana and 18.2% for antidepressants.

Table 3 Toxicological characteristics of victims of fire or burn-related fatalities among all ages in the USA, NVDRS, 2003–2020

Substance	Victims, No. (%)								P value
	Overall		Suicide		Homicide		Undetermined		
	Tested*	Positive*†	Tested*	Positive*†	Tested*	Positive*†	Tested*	Positive*†	
Carbon monoxide	1717 (80.5)	1519 (89.2)	625 (79.4)	554 (88.9)	527 (75.4)	433 (83.8)	565 (87.5)	532 (94.5)	<0.0001
Alcohol	2747 (92.3)	883 (32.5)	1014 (89.7)	306 (30.4)	925 (94.4)	268 (29.5)	808 (93.4)	309 (38.5)	<0.0001
Opiate	2337 (83.1)	516 (22.3)	856 (78.2)	195 (22.9)	791 (85.0)	143 (18.4)	690 (87.6)	178 (25.9)	0.0023
Benzodiazepines‡	1352 (78.7)	278 (20.7)	536 (80.1)	141 (26.6)	408 (71.7)	51 (12.5)	408 (85.2)	86 (21.1)	<0.0001
Marijuana	1802 (65.4)	326 (18.3)	639 (60.0)	112 (17.7)	615 (67.2)	118 (19.6)	548 (70.7)	96 (17.6)	0.6086
Antidepressant	1482 (55.2)	268 (18.2)	588 (56.5)	130 (22.3)	415 (46.6)	41 (10.0)	479 (63.3)	97 (20.3)	<0.0001
Amphetamine	2037 (74.9)	256 (12.6)	755 (71.8)	87 (11.6)	646 (71.1)	87 (13.6)	636 (84.1)	82 (12.9)	0.5132
Anticonvulsants‡	742 (48.3)	75 (10.2)	284 (49.0)	26 (9.2)	211 (40.3)	18 (8.5)	247 (57.2)	31 (12.6)	0.2871
Cocaine	2251 (82.2)	218 (9.8)	806 (76.8)	36 (4.5)	786 (85.0)	118 (15.3)	659 (86.3)	64 (9.8)	<0.0001
Antipsychotic‡	776 (50.7)	48 (6.2)	309 (52.8)	26 (8.5)	214 (41.5)	§	253 (59.0)	14 (5.6)	0.0773
Muscle relaxant‡	806 (52.5)	27 (3.4)	314 (53.8)	12 (3.9)	239 (45.6)	§	253 (59.4)	10 (4.0)	0.4282
Barbiturates‡	1152 (74.3)	13 (1.1)	439 (75.2)	§	363 (67.9)	§	350 (81.2)	§	0.6048

Frequency and proportion of victims tested for substance and those who had positive results reported. χ^2 test and associated p value tested the difference in proportion of victims testing positive for a substance by a manner of death.

*Unknown and missing values were omitted from the denominator when calculating percentages.

†Tested values were used as denominator when calculating percentages of positive results.

‡Variable added in 2013.

§Cell frequency <10, masked.

NVDRS, National Violent Death Reporting System.

Suspect characteristics for homicides and undetermined deaths

A total of 1146 victims across 935 incidents had an identified suspected perpetrator, and 16.9% of incidents had multiple suspected perpetrators (n=1163; median: 1; range: 1–8 perpetrators; table 4). Most suspects were aged 20–44 years (69.7%), 78.0% were male, 36.3% were white, non-Hispanic and 10.3% had known contact with LE within the past 12 months.

A total of 1422 victim–suspect pairs were identified. Among these pairs, 18.2% of victims were the suspect's child, stepchild or child of the suspect's boyfriend/girlfriend, 15.9% were current or former intimate partners, 15.7% of victims were acquaintances and 11.6% were strangers. The suspect was a caregiver for the victim in 10.8% of victim–suspect pairs.

DISCUSSION

This study characterises fire or burn-related fatalities resulting from violence among individuals of all ages using comprehensive, multistate NVDRS data from 2003 to 2020. Most fire or burn-related deaths were among non-Hispanic white people, and white people represented a significant proportion of suicide victims (71.3%), a finding similar to previous studies using NVDRS or National Burn Repository data.^{4,7} One-third of homicide victims were racialised as non-Hispanic black or African American and 44.6% as non-Hispanic white. This is contrary to previous studies using burn centre data indicating higher susceptibility of minorities to assault burns compared with whites.^{7,9} Our study focused solely on mortality data, whereas the other studies examined inpatient data, but still the reasons for these racial differences are unclear. Nonetheless, black people are substantially over-represented in our findings, compared with the percentage of black people in the US (13.6%) population.¹⁷

Children aged 0–19 years represented 12.2% of deaths and most died by homicide. Previous studies indicate that burns among children frequently result from abuse or neglect and can also predict future maltreatment.^{18,19} In the current study, a significant proportion of children aged 0–19 years had either a history of child maltreatment by a caregiver or their death was determined to be attributable to a caregiver's abuse or neglect. A US multicentre study comparing paediatric intentional to non-intentional burns found that patients with intentional burns were more likely to be from families with lower maternal education, no paternal involvement, parental unemployment and higher rates of drug and alcohol abuse among perpetrators.²⁰ These social determinants of health may create stressors that increase the risk of child maltreatment.

More than one-half of victims who died by suicide had a documented current mental health problem but only 28.9% were known to be receiving treatment. Furthermore, many had a history of suicidal thoughts or attempts, or had disclosed intent to die by suicide. Previous studies of self-inflicted burn injuries and deaths in the USA also report a high prevalence of mental health problems among this population.^{8, 21–23} Depression/dysthymia and schizophrenia were more common among victims of suicide versus homicide. A prior NVDRS study comparing burn-related suicides to suicide deaths from other causes found that victims who were white and those with schizophrenia or an eating disorder were more likely to complete suicide by burning compared with other methods.⁴ Our study also identified other predisposing psychosocial factors for suicide by immolation, including substance use/abuse problems, chronic medical illness, financial problems, intimate partner problems and legal stressors, similar to prior research.^{6, 8, 24–27} Many individuals who

Table 4 Characteristics of suspects of fire or burn-related homicides and undetermined deaths among all ages in the USA, NVDRS, 2003–2020

Characteristics	Suspects, No. (%)
Total	1163
Age group, years	
5–19	60 (8.8)
20–44	473 (69.7)
45–64	134 (19.7)
65 and over	12 (1.8)
Unknown/missing (n=484)*	
Sex	
Male	645 (78.0)
Female	182 (22.0)
Unknown/missing (n=336)*	
Race and ethnicity	
White, non-Hispanic	377 (36.3)
Black or African American, non-Hispanic	295 (28.4)
Other, non-Hispanic†	266 (24.4)
Hispanic, any race	102 (9.8)
Unknown/missing (n=123)*	
Suspect attempted suicide after incident	41 (3.5)
Mentally ill suspect	54 (4.6)
Suspect was also a victim in the incident‡	50 (4.3)
Suspected alcohol use by suspect§	50 (7.2)
Suspected other substance use by suspect§	52 (7.5)
Suspect had prior contact with law enforcement§	71 (10.3)
	Victim–suspect pairs, No. (%)
Total	1422
Victim to suspect relationship¶ **	
Child/stepchild††	178 (18.2)
Intimate partner‡‡	156 (15.9)
Acquaintance§§	154 (15.7)
Stranger	114 (11.6)
Friend/roommate (not intimate partner)/schoolmate	88 (9.0)
Parent/grandparent/stepparent¶¶	74 (7.6)
Sibling, grandchild or other family member (eg, cousin, uncle, etc) or in-law	64 (6.5)
Rival gang member	14 (1.4)
Other***	138 (14.1)
Unknown/missing (n=442)*	
Suspect history of abuse of victim¶¶	80 (5.6)
Suspect was a caregiver for this victim¶¶	153 (10.8)

Column percentage may not sum to 100.0% because of rounding error. Table includes 935 incidents involving 1087 homicide victims and 59 victims with undetermined intent (total victims: 1146). There were 1163 suspects identified, resulting in 1422 victim–suspect pairs. *Unknown and missing values were omitted from the denominator when calculating percentages.

†Includes American Indian/Alaska Native, non-Hispanic; Asian/Pacific Islander, non-Hispanic; two or more races, non-Hispanic; or other/unspecified, non-Hispanic.

‡Variable added in 2013.

§Variable added in 2016.

¶Variable described in victim–suspect pair.

**NVDRS recommends use of the sentence 'The victim is the _____ of the suspect' as a guide for an appropriate description of the primary relationship of the victim to the suspect.

††Includes child, stepchild or child of suspect's boyfriend/girlfriend.

‡‡Includes spouse, ex-spouse, girlfriend or boyfriend; ex-girlfriend or ex-boyfriend; girlfriend or boyfriend, unspecified whether current or ex; or victim was new partner of suspect's ex-partner.

§§An 'acquaintance' is someone with or about whom the victim has had some prior interaction or knowledge.

¶¶Includes parent, grandparent, stepparent or intimate partner of suspect's parent.

***Includes foster child; babysitter; current/former work relationship; other person, known to victim; or victim was law enforcement officer injured in the line of duty.

NVDRS, National Violent Death Reporting System.

died by suicide in the current study tested positive for benzodiazepines, opiates and/or antidepressants, however, we could not determine if the drugs were medically prescribed.

Homicide by fire or burn is uncommon and therefore most prior studies are limited by small sample sizes.^{28–31} In our study, one-third of victims died by homicide, frequently perpetrated by someone they knew, and deaths were often precipitated by arson or assault. The victim was often the suspect's child/stepchild, child of the suspect's boyfriend/girlfriend or current/former intimate partner. The suspected perpetrator was rarely a stranger. Frequently, an argument or conflict led to the victim's death or the homicide was related to intimate partner violence. A study of arson-associated homicides in Australia found that an argument or violence between the victim and suspect preceded death in 36.6% of cases.³² Risk factors and predictors of homicide by fire or burn within different relationship types is an area of potential future research.

Limitations

We used multistate NVDRS data to investigate violent deaths from fire or burn injuries in the USA. The data are not nationally representative due to variations in state contributions and reporting completeness over the years. Reported fatalities by US region may reflect when states joined the NVDRS rather than increased incidence. We do not have any information about non-fatal fire or burn injuries. Our study refrains from implying causality and explores factors that are descriptively rather than simply analytically significant, considering potential differences by manner of death. Determining intentionality of deaths is complex and 28.5% of fatalities were categorised as undetermined intent. The inclusion of children (23.3%) in the homicide deaths may have slightly skewed some findings (eg, young children are unlikely to be diagnosed with substance use problems).

NVDRS limitations impacting data availability and use include reliance on quality and completeness of source documents; variation in data elements collected over time; and non-standard variables. Consequently, frequencies of certain variables are likely underestimated. Inconsistent collection and reporting of toxicology data across jurisdictions poses additional challenges.

While we identified 114 additional fire/burn-related cases and excluded 405 through narrative review, reliance on narrative data introduces potential limitations related to information availability, coder interpretation and human error. To maintain accuracy, suspect characteristics were reported at the incident level to avoid overcounting suspects in incidents involving one suspect and >1 victims. In incidents with multiple victims, variables unique to each suspect and victim (ie, victim-to-suspect relationship) were reported in pairs.

CONCLUSION

This study explores violence-related fire and burn fatalities, an understudied cause of death. Individuals with mental health concerns, children and individuals experiencing intimate partner violence were found to be at particular risk. Addressing this complex issue will require a holistic approach and collaboration between medical, public health, criminal justice and social service agencies. The findings underscore the urgency for promoting broad violence and suicide mitigation efforts as well as developing prevention strategies tailored to individuals at heightened risk of engaging in or being the victim of intentional burn behaviours. Using comprehensive approaches, including early mental health evaluation and treatment, substance use disorder services and

crisis intervention is imperative.^{9,33} Moreover, greater resources should be allocated to assisting individuals experiencing intimate partner violence and aiding healthcare professionals in identifying and reporting indicators of intentional burns and other signs of child abuse.³⁴ These strategies may prevent intentional burn injuries and help address underlying factors that contribute to violence.

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