



RESEARCH



Firefighter Injuries on the Fireground

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October 2022

Key Findings

Firefighters in the United States experienced an average of 23,610 non-fatal injuries on the fireground each year from 2016 through 2020.

Injuries involving exposure to a hazard (such as heat, smoke, or toxic agents) and overexertion or strain were the most common injuries experienced by firefighters on the fireground.

Three in ten fireground injuries (27 percent) resulted in lost work time, while just over two in five injuries (43 percent) were “report only” and did not result in lost work time. Another 17 percent of the injuries required treatment by a physician but resulted in no lost time, while 13 percent were classified as first-aid only.

Three in five fireground injuries occurred outside the structure, with a somewhat smaller share of injuries sustained inside a structure.

Introduction

Firefighters are regularly exposed to an array of safety and health hazards at the scene of a fire. In addition to working in the presence of fire or explosive materials, firefighters must contend with weather-related temperature extremes, physical demands involving awkward postures and heavy loads, work environments that include slippery surfaces or the presence of sharp objects, exposure to chemical and biological agents, potential lack of adequate oxygen, fall hazards and falling objects, and any number of additional health and safety threats.

Information about firefighter injuries—how and where they occur, activities at the time of injury, and other relevant information—is critical for identifying risk factors, developing prevention programs, and guiding resource decisions, as well as informing other areas of intervention.

¹See *Firefighter Fatalities in the U.S. in 2021* by Rita F. Fahy and Jay T. Petrillo.

²See *United States Firefighter Injuries in 2020* by Richard Campbell and Ben Evarts.

This report covers the injuries experienced by U.S. firefighters on the fireground for the five-year period from 2016 through 2020. The data are derived from the U.S. Fire Administration’s National Fire Incident Reporting System (NFIRS) in conjunction with the annual fire experience survey administered by the National Fire Protection Association. The use of NFIRS data enables a more detailed examination of the factors related to injury incidents than would be possible with data produced by the NFPA survey alone. The data in this report are estimates of firefighter injuries from fires reported to US municipal fire departments and so exclude firefighter injuries reported only to state or federal agencies or industrial fire brigades.

In the tables and figures in this report, firefighter injuries are rounded to the nearest ten. Note that the data presented in the body of this report represent only results for major response categories. More detailed information is available in the [accompanying tables](#).

This report focuses on non-fatal injuries that occurred on the fireground that were reported through the National Fire Incident Reporting System. NFPA also publishes two reports that examine the aspects of firefighter injuries not covered here: *Firefighter Fatalities in the United States*¹ and *U.S. Firefighter Injuries*.² The latter provides the latest estimates on all firefighter injuries, including injuries that occurred off the fireground, as well as documented exposures to infectious diseases.

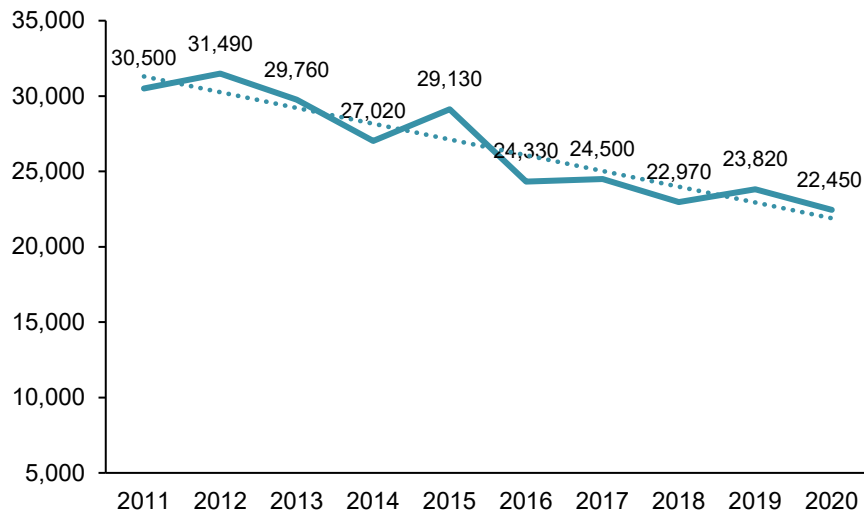
Patterns of Firefighter Injuries on the Fireground

NFPA estimates that firefighters sustained a total of 118,070 injuries on the fireground during the five-year period from 2015 to 2019, an average of 23,610 non-fatal injuries each year. While substantial, the number of injuries sustained over the latest five-year period is significantly lower than the estimated total of 147,900 injuries experienced from 2011 through 2015, an average of 29,580 injuries each year. Estimates of the

annual number of fireground injuries dating to 2005 can be found in Table 1 of the [accompanying tables](#) of this report.

Figure 1 provides a visual representation of the fireground injury trend from 2011 to 2020. The figure shows a clear downward trend, with a sizeable increase in 2015 representing the most significant interruption of the decline. It should be noted that the encouraging decline in firefighter injuries continues a trend that has been consistently documented in earlier NFPA reports on fireground injuries. The estimated injury totals in 2018 and 2020 represent the lowest fireground injury counts over this period.

Figure 1. Fireground Injuries by Year, 2011–2020

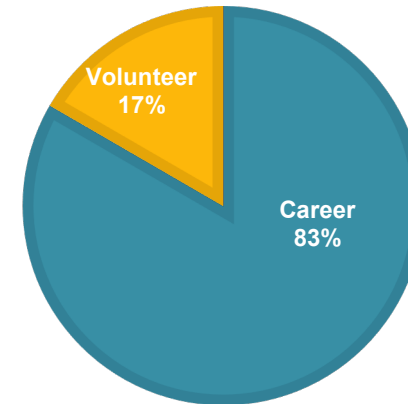


Injury Victims

The vast majority of fireground injuries were experienced by males, with females accounting for only 4 percent of the injuries. According to NFPA’s most recent *US Fire Department Profile*, women accounted for 8 percent of the firefighter workforce in 2019, suggesting that female firefighters may have experienced a disproportionately lower share of injuries relative to males. However, additional research is needed to confirm differences in the injury burden between male and female firefighters.

Career firefighters accounted for just over four out of five non-fatal injuries (83 percent), while volunteer firefighters sustained the remaining 17 percent of injuries, as indicated in Figure 2.

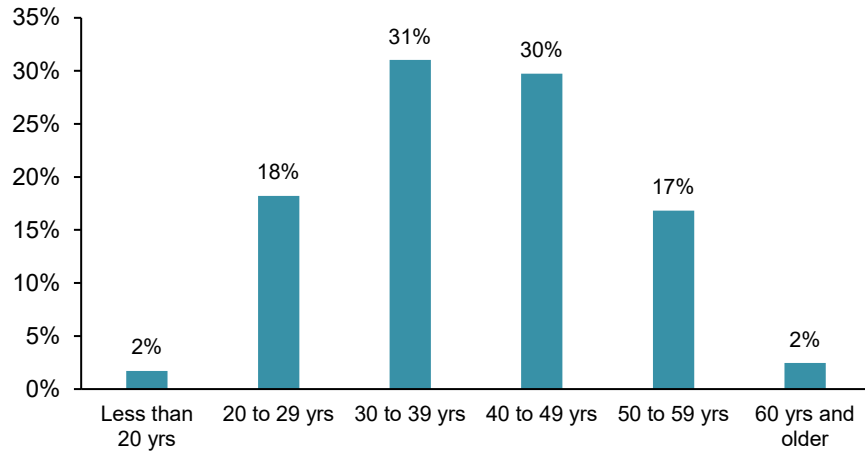
Figure 2. Fireground Injuries by Type of Service, 2016–2020



Injuries by Age

Fireground injuries by age are broken down below in Figure 3. As the figure indicates, firefighters in the 30 to 39 and 40 to 49 age groups had the highest injury shares and together accounted for three-fifths of the injuries. The 20 to 29 age group (18 percent) and 50 to 59 age group (17 percent) accounted for the majority of the remaining fireground injuries.

Figure 3. Fireground Injuries by Victim’s Age, 2016–2020



Leading Causes of Injury

Figure 4 shows the leading causes of fireground injuries. As indicated, the two leading causes of injury, exposure to hazards and overexertion or strain, together account for well over half of the injuries (56 percent). Injuries involving overexertion or strain consistently rank among the most common injuries experienced by firefighters (volunteer and career) on the fireground. Exposure to hazards includes exposure to fire products, such as heat or smoke.

Other leading causes of fireground injury included slips or trips, falls, contact with objects, and being struck or assaulted by a person, animal, or moving object.

Injuries by Type of Fire Incident

Firefighters respond to different types of fire incidents. The vast majority of the fireground injuries (81 percent) occurred at structure fires. Much smaller shares of injuries occurred at vehicle fires, natural vegetation fires, outside rubbish or unclassified fires, or fires in mobile properties used as fixed structures, as shown in Figure 5.

Figure 4. Fireground Injuries by Cause, 2016–2020

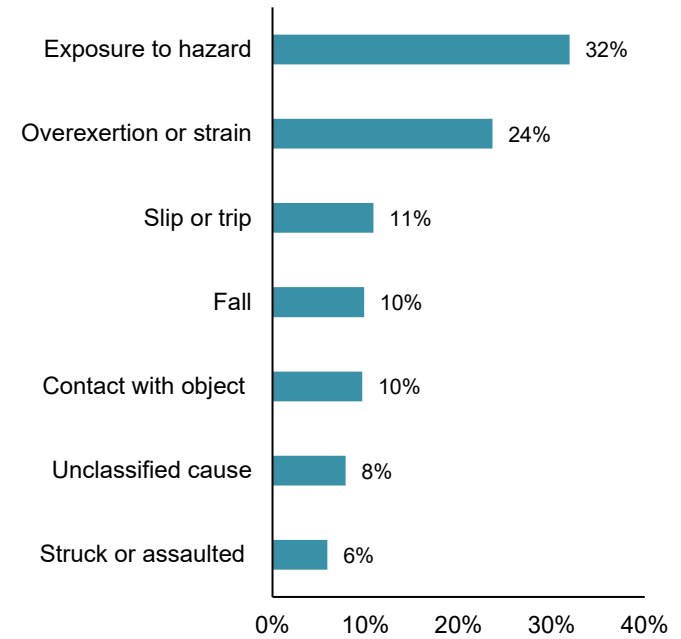
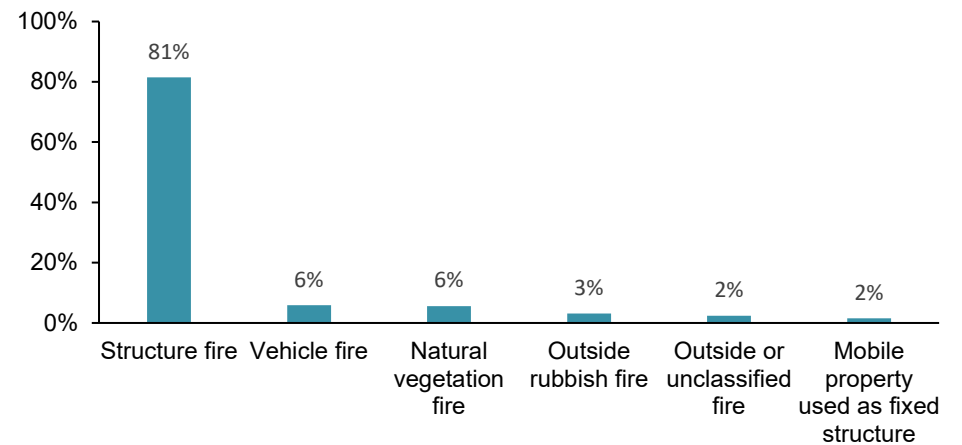


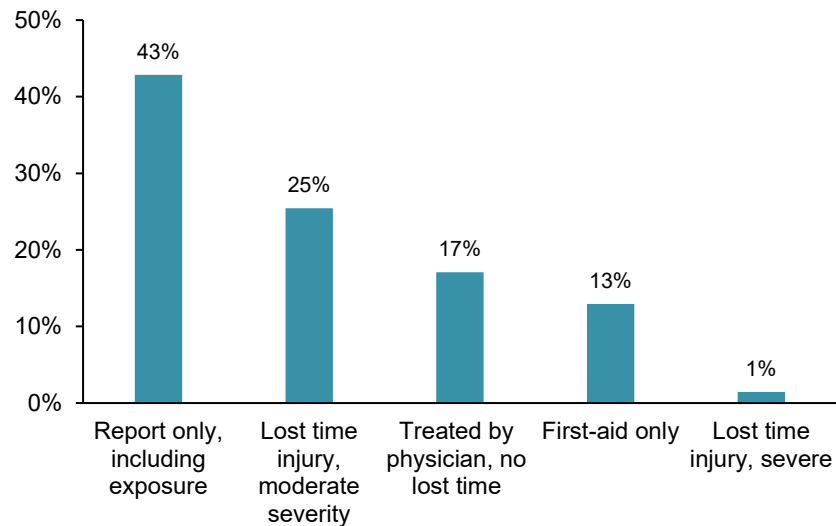
Figure 5. Fireground Injuries by Type of Incident, 2016–2020



Severity of Injury

Firefighter injuries are broken down by severity in Figure 6. Slightly more than two in five injuries (43 percent) were classified as “report only.” Injuries resulting in lost work time accounted for a little over one-quarter of the injuries (25 percent), most of which were of moderate severity. Another one-fifth of the injuries (17 percent) required treatment by a physician without any loss of work time, while 13 percent were classified as first-aid only. It should be noted that the “report only” injuries included exposure to toxic substances or other harmful agents and that any health effects from such exposures might only be realized after repeated exposure or a prolonged latency period.

Figure 6. Fireground Injuries by Severity of Injury, 2016–2020

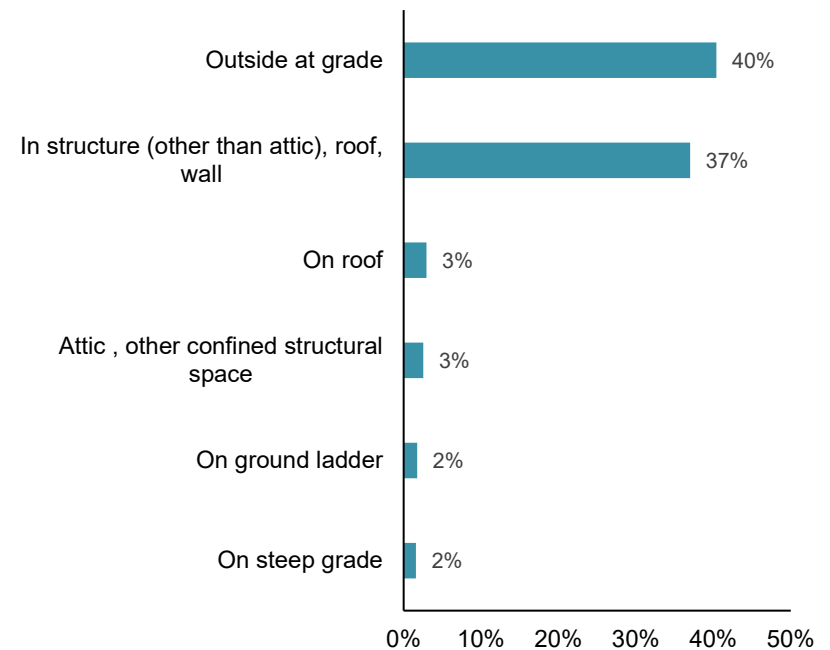


Injury Location

Nearly four in five fireground injuries occurred either outside at grade level (40 percent) or inside a structure other than an attic (37 percent), as shown in Figure 7. Smaller shares of injuries occurred while firefighters were on a roof, in an attic or other confined structural space, on a ground ladder, or on a steep grade.

Injury locations do not by themselves provide any indication of the relative chance of injury in specific locations, as these also reflect the number of firefighters on the scene and the amount of time spent in one location versus another. Hence, the higher share of injuries that occurred outside may reflect a greater number of firefighters or greater person hours in outside locations. They do, nevertheless, indicate that firefighters are exposed to hazards inside and outside structures on the fireground.

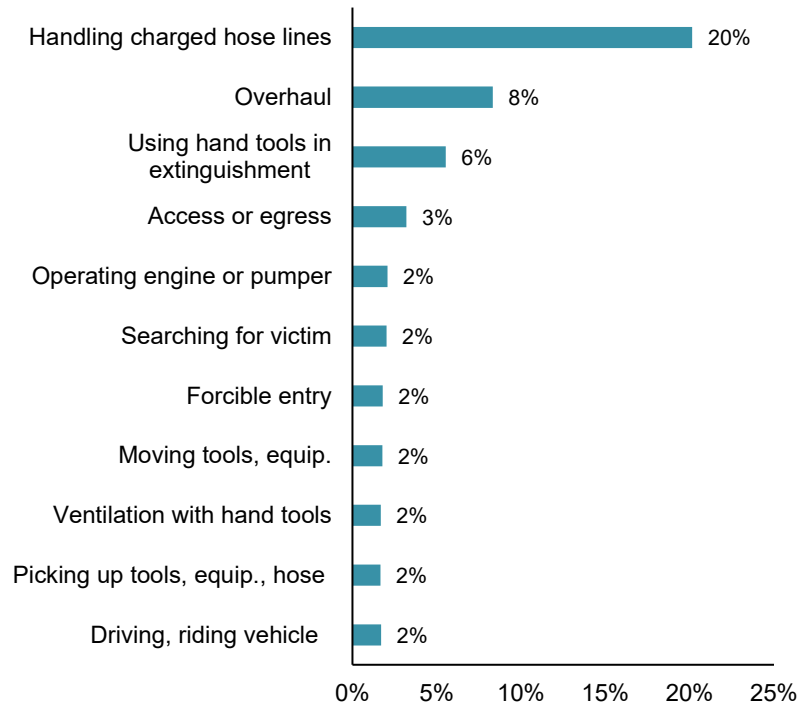
Figure 7. Fireground Injuries by Leading Injury Locations, 2016–2020



Activity When Injured

The specific activity most often associated with fireground injuries was handling charged hose lines, which accounted for one in five injuries (20 percent). Injuries during overhaul (8 percent) and while using hand tools during extinguishment (6 percent) were the next leading causes of injury. Smaller shares of injuries were associated with many different activities, as shown in Figure 8.

Figure 8. Fireground Injuries by Activity, 2016–2020

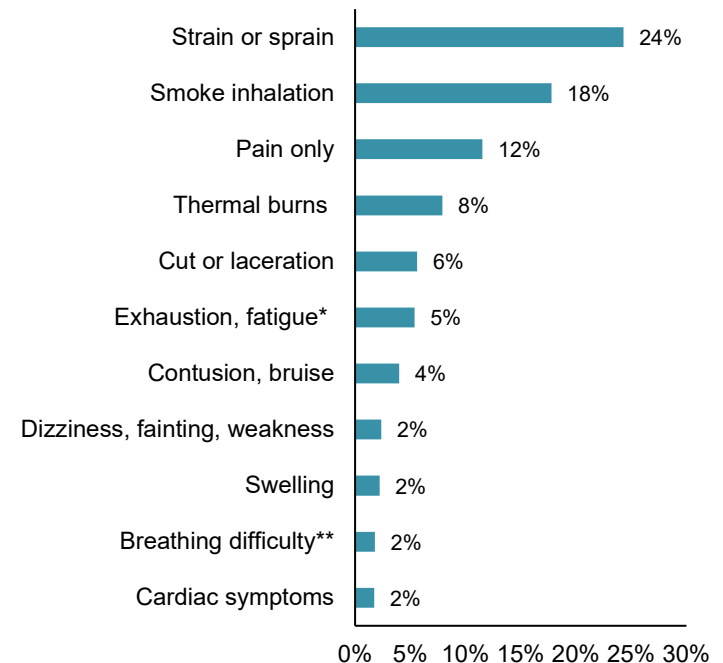


Primary Symptom of Injury

Sprains or strains were the most common injury symptom experienced by firefighters, accounting for nearly one-quarter of the fireground injuries (24 percent). The prevalence of sprain or strain injuries is consistent with prior research findings.

As shown in Figure 9, firefighters experienced different forms of physical trauma, such as smoke inhalation, thermal burns, cuts or lacerations, contusions or bruises, fractures, and swelling injuries. Firefighters also experienced a variety of symptoms influenced by the physical demands of their work tasks, the environmental conditions in which they work, and their own personal conditioning, such as exhaustion or fatigue, dizziness, fainting or weakness, breathing difficulties, or cardiac symptoms.

Figure 9. Fireground Injuries by Primary Symptom, 2016–2020



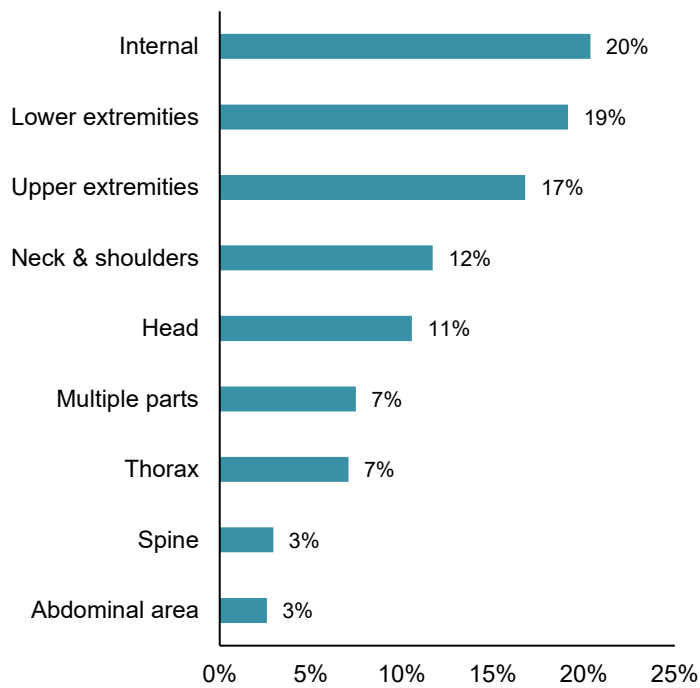
*Includes heat exhaustion

**Includes shortness of breath

Primary Body Part Injured

Fireground injuries most often involved the extremities, as shown in Figure 10. Injuries to lower (19 percent) and upper (17 percent) extremities accounted for nearly two in five injuries, and one in ten injuries involved hands or fingers. Acute trauma may have caused some of these injuries, but they also involved parts of the body that may be injured as a result of repetitive or acute strain. Internal injuries most often involved the trachea and lungs.

Figure 10. Fireground Injuries by Body Part, 2016–2020



Factors Contributing to Injuries

Injury reports sometimes include limited information on the factors that contributed to fireground injuries. As shown in Table A, factors relating to fire development (such as smoke conditions or explosions) contributed to approximately three in ten injuries (28 percent), while slippery or

uneven surfaces contributed to another 14 percent. Collapses of structural elements or falling objects also contributed to a substantial share of injuries (7 percent). Holes or being lost, caught, trapped, or confined contributed to comparatively smaller shares of injuries.

Table A. Factors Contributing to Injuries, 2016–2020

Injury Factor	Percent
Fire development	28%
Fire progress, including smoky conditions	24%
Slippery or uneven surfaces	14%
Uneven surface, including holes in the ground	5%
Icy surface	3%
Wet surface	2%
Loose material on surface	2%
Collapse or falling object	7%
Falling objects	2%
Ceiling collapse	2%
Holes	2%
Lost, caught, trapped, or confined	1%
Unclassified factor	9%
None	17%

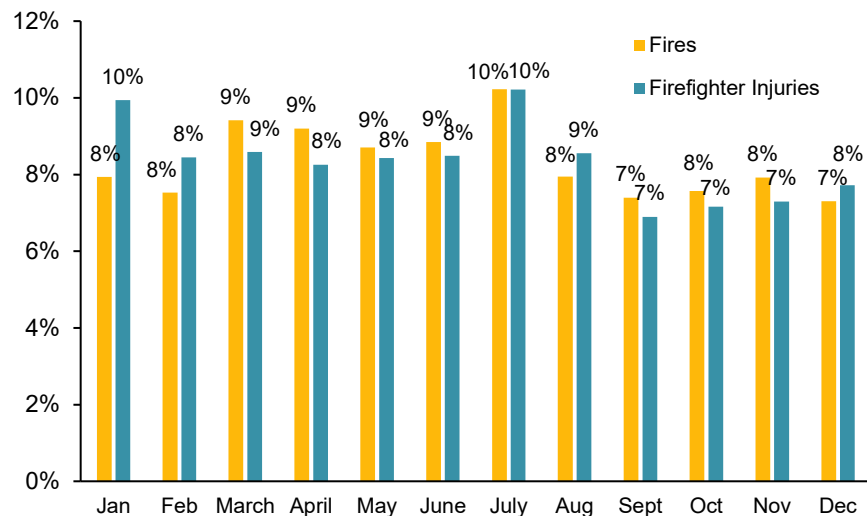
Injuries by Month

Fireground injuries were highest in January and July, with 10 percent of the injuries occurring in each of these months. March and August each accounted for 9 percent of injuries. Injuries were lowest in September, October, and November.

Since the incidence of fires by month can vary and thereby influence opportunities for injury on a monthly basis, Figure 11 shows the monthly distribution of fireground injuries and fire incidents. As the figure indicates, the monthly share of injuries was highest relative to the

distribution of fires in December, January, February, and August, potentially reflecting the influence of working in cold and hot weather conditions. The monthly share of injuries was somewhat lower relative to the distribution of fire incidents in most of the remaining months.

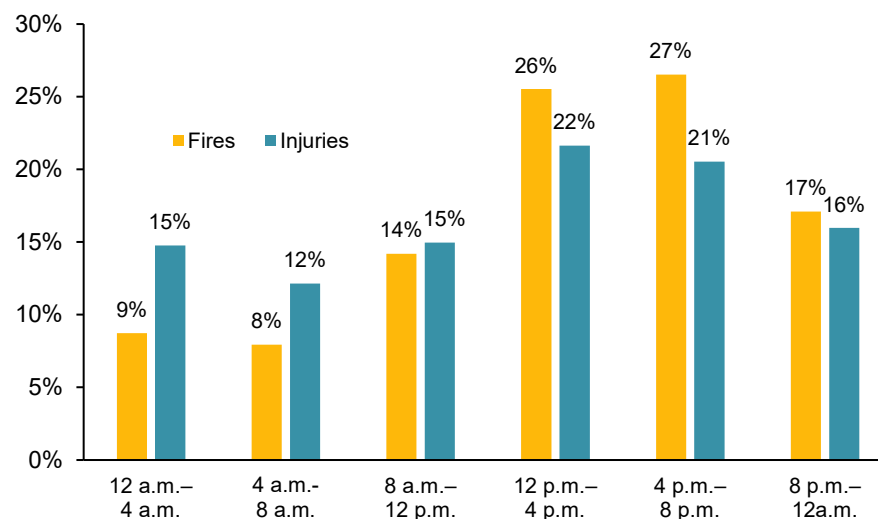
Figure 11. Fireground Injuries and Fires by Month, 2016–2020



Injuries by Time of Day

Slightly more than two in five fireground injuries occurred in fires that took place between 12 p.m. and 8 p.m., but these hours also accounted for over half of the fires, as shown in Figure 12. As the figure indicates, injuries were low relative to fires in the period from 12 p.m. to 8 p.m. Although there were fewer fires between 12 a.m. and 8 a.m., injuries were substantially higher relative to the share of fires at these hours. Such factors as working in dark environments or sleep disturbance may play a role in this injury pattern.

Figure 12. Fireground Injuries and Fires by Time of Day, 2016–2020



Discussion

Firefighters are regularly at risk of injury due to work activities that involve exposure to fire and explosion hazards, carrying heavy equipment and injury victims, contending with hot and cold weather conditions, working on slippery and uneven surfaces, assuming awkward body postures, and contending with multiple other hazards.

Sprain or strain and overexertion injuries have been identified as prevalent forms of firefighter injury in [other research](#). Factors that contribute to these injuries include repetitive motion, inadequate fitness, and activities that compromise trunk stability.

While any number of routine firefighter tasks will pose limits for injury intervention efforts, research has nevertheless identified potential opportunities for reducing the risk of sprain, strain, and overexertion injuries. For instance, better [aerobic fitness](#) has been found to be associated with a lower risk of sprain and strain injuries among firefighters, a finding which underscores the importance of structured fitness programs, particularly for volunteers who don't work in physically demanding jobs. Research also suggests the use of programs

to enhance [core strength and functional movement performance](#) can reduce injuries caused by awkward postures, while greater attention to [nutrition and fitness](#) has been identified as a way to reduce musculoskeletal injuries. Training and education on [safe lifting techniques and the use of ergonomically designed equipment](#) represent additional injury reduction interventions.

In addition to sprain and strain or exhaustion-related injuries, volunteer firefighters also experienced an array of traumatic injuries, including cuts and lacerations, burns, smoke inhalation, bruises, and fractures. Although the fireground is an inherently hazardous environment, good health and safety practices can reduce the risk of injury, beginning at the pre-incident phase with the development of safety-related standard operating procedures and training programs for all firefighter activities. Since personal protective equipment is an essential safeguard against firefighter injury, pre-incident safety preparations must also ensure that personal protective equipment is properly maintained and meets the prevailing equipment codes.

At the incident scene, it is critical to follow standard operating procedures before undertaking interior firefighting. This includes 360-degree size-up, determination of whether the situation justifies entry, identifying points of egress, and ensuring the use of personal protective equipment. The assignment of trained safety officers to the fire scene can help ensure the identification of hazards and curtail any inclinations of crew members to assume unnecessary risks by engaging in a quick response. The occurrence of a substantial share of injuries during overhaul indicates that hazards are not restricted to extinguishment activities and that appropriate safety practices are needed throughout the response.

It is also important to note that staffing is another critical influence on firefighter injury experience. A [recent review](#) of the impact of crew size on firefighter health and safety highlighted a variety of ways that the number of personnel deployed to events may influence operational effectiveness, which, in turn, is likely to impact health and safety risks. For instance, the number of personnel available to work at a fire scene

can impact fatigue, physical exertion, cardiac demands, and muscular strain associated with performing work tasks. Having less personnel can lead to longer work times and more intense workloads. The authors recommend that resource requirements take into account firefighter health and safety needs, not simply operational needs for safeguarding people and property.

Acknowledgments

The National Fire Protection Association® thanks all the fire departments and state fire authorities who participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA® fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

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NFPA No. USS02

How National Estimates Statistics Are Calculated

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns of fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread and automatic detection and suppression equipment. For more information about NFIRS, visit <https://nfirs.fema.gov/NFIRSWeb/login>.

NFIRS has a wide variety of data elements and code choices. The NFIRS database contains coded information. Many code choices describe several conditions. These cannot be broken down further. For example, area of origin code 83 captures fires starting in vehicle engine areas, running gear areas or wheel areas. It is impossible to tell the portion of each from the coded data.

NFPA's fire department experience survey provides estimates of the big picture.

Each year, NFPA conducts an annual survey of fire departments that enables us to capture a summary of the fire department experience on a larger scale. Surveys are sent to all the municipal departments protecting populations of 5,000 or more and a random sample, stratified

by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys is returned, representing about one of every ten U.S. municipal fire departments and about one-third of the U.S. population.

The survey is stratified by the size of the population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars) for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries by type of duty and nature of illness; (3) the number and nature of non-fire incidents; and (4) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results. The results of the survey are published in the annual report *Fire Loss in the United States*.

Projecting NFIRS to National Estimates

As noted, NFIRS is a voluntary reporting system. Different states and jurisdictions have different reporting requirements and practices. Participation rates in NFIRS are not necessarily uniform across regions and community sizes, both factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern that a second database—the NFPA survey—is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

Only data originally collected in NFIRS 5.0 is included in the calculations of the 2016–2020 national estimates for firefighter injuries in structure fires. The portion of fires and firefighter injuries originally collected in NFIRS 5.0 compared to the earlier NFIRS 4.1 version has increased steadily over time. The percent of fires coded in version 5.0 for the 2014 to 2018 period ranged from 97 percent to 100 percent.

This update for 2016–2020 includes injuries that occurred at all fires (incident type 110–171), at the fireground (where injury occurred codes 5 and 6), and the severity of the injuries (1 to 5). Except where otherwise noted, all the tables in this report are based on fireground injuries that occurred at all fires. The national annual estimates of firefighter injuries were weighted for the individual years using total fireground injuries from the annual NFPA fire experience survey.

In this report, unknown data was assumed to have the same proportional distribution as the distribution where the data was known. The “Other” category includes cases specifically coded as “other” and cases coded in specific categories with very low frequency. Note that in the

accompanying tables for this report, the number of firefighter injuries has been rounded to the nearest ten and percentages have been rounded to the nearest whole percent. Totals in tables may not equal sums due to rounding.