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The Economics of Firefighter Injuries in the United States: Executive Summary

FINAL REPORT BY:

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Errata

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Reference:

Page iii, second paragraph, first sentence was deleted.

~~NFPA's firefighter injury studies indicate that although other loss indicators of the nation's fire problem are declining, the rate of firefighter injury per fire incident is not.~~

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FOREWORD

According to NFPA's most recent study on firefighter injuries, 58,835 firefighter injuries were reported in the U.S. in 2017. Of these, 24,495 occurred at the fireground. Strain, sprain, muscular pain resulted in almost half of the injuries received during fireground operations (48%) and more than half during non-fireground activities (56%). In addition to injuries, there were 7,345 documented exposures to infectious diseases (e.g., hepatitis, meningitis, HIV, other) in 2017. This amounts to 0.3 exposures per 1,000 emergency medical service runs by fire departments. There were an estimated 44,530 documented exposures to hazardous conditions (e.g. asbestos, chemicals, fumes, radioactive materials, other) in 2017. In addition, there were an estimated 15,430 collisions involving fire department emergency vehicles responding to or returning from incidents.

A deeper understanding of the costs associated with these injuries is needed in order to quantify the impact on the nation's resources dedicated to fire safety and provide benchmarks to evaluate strategies to reduce these numbers in the future.

The Research Foundation initiated this project with an overall goal to assess the economic impact of firefighter injuries in the United States. Building upon existing information on firefighter injuries available from NFPA and other sources, and the broader literature related to the indirect and direct costs of injuries, the project: 1) characterized the annual number and types of firefighter injuries; 2) researched both indirect and direct costs of these injuries borne by firefighters and their communities; 3) established a framework to assess and benchmark these costs; and 4) identified current data shortcomings and gaps.

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The content, opinions and conclusions contained in this report are solely those of the authors and do not necessarily represent the views of the Fire Protection Research Foundation, NFPA, Technical Panel or Sponsors. The Foundation makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

About the Fire Protection Research Foundation

The [Fire Protection Research Foundation](#) plans, manages, and communicates research on a broad



range of fire safety issues in collaboration with scientists and laboratories around the world. The Foundation is an affiliate of NFPA.

About the National Fire Protection Association (NFPA)

Founded in 1896, NFPA is a global, nonprofit organization devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. The association delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy; and by partnering with others who share an interest in furthering the NFPA mission.



[All NFPA codes and standards can be viewed online for free.](#)

NFPA's [membership](#) totals more than 65,000 individuals around the world.

Keywords: costs, economics, exposure, fire, firefighter, illnesses, injury, losses

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FEMA



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Introduction

In 2016, U.S. fire departments received 35.3 million calls, of which 1.8 million were for fire and hazardous materials incidents, while another 22.8 million were requests for medical aid (National Fire Protection Association, 2019). Over one million firefighters responded to these calls, split between career (33%) and volunteer (67 %) (Evarts and Stein, 2019). The health risks faced by firefighters, associated with response, suppression, rescue and aid related activities, are considerable. In 2016, 69 firefighters died on-duty and another 62 085 suffered injuries requiring treatment by a medical professional. While the number of fire incidents and injuries has been trending downward, the decline in non-fatal injuries has been slower. Although there is a lengthy literature that describes the cause, nature, and severity of firefighter injuries, less is known about the economic impact of non-fatal injuries.

The economic consequences of injuries go beyond the costs associated with direct medical expenses and workers compensation. Significant indirect costs include lost productivity and diminished quality of life. Further, because fire departments are funded from taxes and other public sources of revenue, and the benefits of their services are a common good, firefighter injuries represent a societal cost borne by many. Activities that prevent and mitigate firefighter injuries yield economic benefits to the community. Additionally, focusing on the economic costs of injuries, as opposed to the number of injuries, should provide insight into the value of risk reduction efforts that do not eliminate, but reduce injury severity and downtime.

NIST Technical Note 2078 identifies, summarizes, and evaluates the available data and literature describing the economic costs associated with non-fatal firefighter injuries, illnesses, health exposures, and occupational disease ('health outcomes') resulting from line-of-duty activities.

The objectives of the analysis described was to:

- (1) Characterize the annual number and types of firefighter injuries;
- (2) Research direct and indirect costs of these injuries born by firefighters and their communities;
- (3) Establish and utilize a framework to assess and benchmark these costs; and
- (4) Identify current data shortcomings or gaps.

Approach

National firefighter non-fatal health outcome data sources are compared and contrasted in terms of coverage and detail provided. The three main data sources are identified below. A survey of the economic injury literature is used to estimate the direct and indirect costs of non-fatal health outcomes. A matching procedure is used to combine the statistical and economic data to produce an annual estimate of firefighter non-fatal health outcome costs, which provides a benchmark for annual tracking.

National Firefighter Injury Data

- National Fire Protection Association
 - Data source: *National Fire Experience Survey*
- U.S. Fire Administration
 - Data Source: *National Fire Incident Reporting System*
- U.S. Bureau of Labor Statistics
 - Data Source: *Survey of Occupational Injuries and Illnesses*

Types of Injuries Evaluated in the Economic Literature

- Costs of Injuries and Illnesses, General Population
- Costs of Occupational Injuries and Illnesses, All Professions
- Costs of Occupational Injuries and Illnesses, Firefighters

Types of Economic Values Considered in the Economic Literature

- Medical and Emergency Services Costs
- Wages and Household Work Losses
- Administrative and Legal Costs
- Workplace Disruption Losses

Main Findings

Mapping the injury data with the economic injury (cost) data produces a range between \$0.1 million to \$29 billion in measured annual costs and losses due to firefighter injuries, illnesses, exposures, and occupational disease. To reduce the amount of error and uncertainty in the estimates, the range was narrowed down by eliminating matching-estimates based on incomplete and partial data or resulting from the use of unrealistic assumptions. An example of the use of incomplete injury data includes those estimates based on NFIRS data, which accounts for only injuries that required medical attention and were associated with a reported incident. An example of matching-estimates based on an unrealistic assumption includes those estimates when using values derived from the Maximum Abbreviated Injury Scale (MAIS), which defines injury severity differently than used by the national injury datasets, thereby requiring some arbitrary assignment of values (e.g., every injury is ‘critical’).

Figure ES-1 presents the matching-estimates based on NFPA’s annual statistics, which were found to be the most complete of the three datasets examined, and those economic values determined to be the most comprehensive. Focusing on these estimates, the range is \$1.2 billion to \$18 billion. Dropping the highest and lowest estimates produces a range of \$1.6 billion to \$8.4 billion. Excluding those estimates found in the TriData Report (2005), so to provide a

unique comparison, the range becomes \$1.6 billion to \$5.9 billion. Note these estimates track well against the TriData Report estimates of \$2.8 billion to \$7.8 billion (inflation adjusted).

An advantage of the current approach is the ability to track injury costs by cause and nature (due to the matching procedure). Given the range of \$1.6 billion to \$5.9 billion is consistent with previous literature and is based on fewer data limitations than the other (lower) estimates, this is the most defensible estimate.

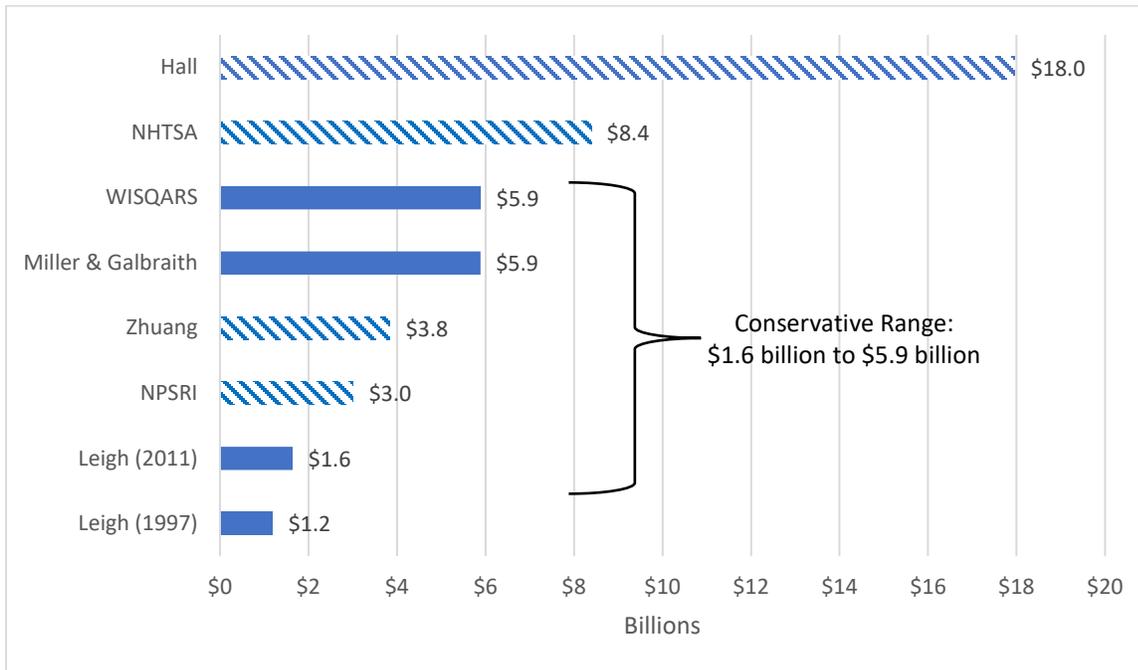


Figure ES-1. Cost estimates of firefighter injuries based on NFPA injury data (\$ billion). The crosshatch identifies those estimates based on TriData Report (2005).

Table ES-1 presents the total annual costs normalized (divided by) the numbers of fire departments, firefighter injuries, firefighters, and total calls to provide additional perspective of the magnitude. Based on the high estimate (\$5.9 billion), firefighter injuries result in a loss equivalent to \$197 860 per fire department per year, \$5412 per firefighter per year, or \$170 per call per year. The average lost per injury is \$95 031.

Table ES-1. Total annual cost of firefighter injuries normalized on a per-unit basis.

Unit	Number	Total Firefighter Injury Cost Per Unit	
		Low Estimate (\$1.6 Billion)	High Estimate (\$5.9 Billion)
Fire Departments ^a	29 819	\$53 657	\$197 860
Firefighter Injuries ^b	62 085	\$25 771	\$95 031
Firefighters ^a	1 090 100	\$1468	\$5412
Total Calls ^c	34 683 500	\$46	\$170

Sources: ^a Evarts and Stein (2019), ^b Haynes and Molis (2017), ^c NFPA (2019)

Identified Data Gaps

The national data sources, described above, account for injuries, illnesses, and health exposures that typically occur during line-of-duty (on-duty) activities, transport, or as part of training. However, they do not capture longer-term health effects from occupational diseases, such as cancer. Tracking the national prevalence of occupational diseases from long-term exposures of firefighters to toxic environments does not occur (Fahy, et al. 2017). Statistics of firefighter deaths due to occupational diseases can provide some insights into their lethality, but they may provide only limited information related to their prevalence in active and retired firefighters. For example, if the relative lethality of occupational diseases is equal across causes, and exposure rates are constant over time, fatalities from occupational disease would provide insights into prevalence in active and retired firefighters. However, it is unlikely these conditions exist.

Needs Assessment

There are significant data challenges that prevent the full accounting of the economic consequences resulting from these negative health outcomes. Data gaps exist, largely due to delays between exposure and the onset of symptoms, in capturing the incidence and economic consequences associated with firefighter cancer and other occupational diseases, including post-traumatic stress injuries.

Data Collection Needs:

- Tracking incidence of occupational disease (and equivalent for volunteer firefighters) and long-term health consequences
 - Data can help establish links to exposure for long term disease
 - To establish links requires better and more consistent reporting of incidents
- Better understanding of mental health and post-traumatic stress injuries, impact on fire departments, and direction of future trends
- Better understanding of costs related to:
 - Direct and indirect cost data specific to firefighting activities
 - Injury litigation and backfill

If better quantification and annual tracking of firefighter injuries, illnesses, health exposures, and occupational disease are to occur, improvements in data collection are needed. Because data collection efforts require time and resources, such efforts are likely only sustainable if the information derived from these efforts are aligned with incentives for their collection—i.e., the effort of increased data collection should be at least proportional to its usefulness to fire departments. Incentives need to be identified and articulated, particularly for those responsible for the data entry, and the incentives should be of value to company commanders, for example.

Incentives for increased data collection:

- To reduce the frequency and severity of injuries, illnesses, health exposures, and occupational disease

- To improve cost management by establishing industry injury cost benchmarks. This data can inform discussions with decision makers. Fire departments can compare costs to costs found in the report to see how injuries and costs compare with peers.
- To estimate return-on-investment on activities and equipment to enhance firefighter health (e.g., health and well-being programs, training, PPE, fire prevention efforts)
- To create friendly competitions between battalions (e.g., who has the ‘best’ incident reports) or to provide recognition at national conferences

Improving the frequency and consistency of data collection efforts requires mechanisms or tools to reduce barriers of data entry, including leveraging pre-existing systems to reduce the burden on resources. For example, NFORS automates real-time data collection through connection with pre-existing CAD systems, eliminating touch points, data entry duplication, and error, while providing enhanced data analytics and visualization capabilities for departments. The Fire Exposure Module allows firefighters to document and track incident and health exposures, fully integrated with CAD data, over their career.

Mechanisms to Increase Data Collection and Early Warning:

- Use of pre-existing systems/tools through following channels:
 - NFORS & Fire Exposure Module
 - Integrated with CAD
 - Includes physical and behavioral health exposures
 - Linkage with National Cancer Registry
 - NFIRS
 - Fire Service Casualty Module
 - CAD
 - Increase coverage to include more metro areas
 - Workers compensation reports of injuries
- Link hospital discharge data with industry and occupation data¹
- Regular health screenings

¹ E.g., see Taylor and Frey 2013.

References

- Butry, D.T., D. Webb, S. Gilbert, and J. Taylor. 2019. *The Economics of Firefighter Injuries in the United States*. NIST Technical Note 2078. Gaithersburg, MD: National Institute of Standards and Technology.
- Evarts, B., and G. Stein. 2019. "U.S. Fire Department Profile 2017." National Fire Protection Association.
- Fahey, R.F., P.R., LeBlanc, and J.L. Molis. 2017. "Firefighter Fatalities in the United States-2016." National Fire Protection Association.
- Hall, J. 2014. "The Total Cost of Fire in the United States." National Fire Protection Association.
- Haynes, H.J.G. and J.L. Molis. 2017. "United States Firefighter Injuries – 2016." National Fire Protection Association.
- Leigh, J.P. 2011. "Economic Burden of Occupational Injury and Illness in the United States." *Milbank Quarterly* 89: 728-772.
- Leigh, J.P., S.B. Markowitz, M. Fahs, C. Shin, P.J. Landrigan. 1997. "Occupational Injury and Illness in the United States: Estimates of the Costs, Morbidity, and Mortality." *Archive of Internal Medicine* 157(7): 1557-1568.
- Miller, T.R., and M. Galbraith. 1995. "Estimating the Costs of Occupational Injury in the United States." *Accident Analysis and Prevention* 27(6) 741-747.
- National Fire Protection Association. 2019. Fire Department Calls. Available at: <<https://www.nfpa.org/News-and-Research/Data-research-and-tools/Emergency-Responders/Fire-department-calls>> Last Accessed 05 August 2019.
- National Highway Traffic Safety Administration (NHTSA). 2002. "The Economic Impact of Motor Vehicle Crashes 2000." NHTSA Technical Report.
- National Public Services Research Institute. 1993. "Societal Costs of Cigarette Fires." Consumer Product Safety Commission Technical Report.
- Taylor, J.A., and L.T. Frey. 2013. "The Need for Industry and Occupation Standards in Hospital Discharge Data." *Journal of Occupational and Environmental Medicine* 55(5): 495-499.
- Tridata Corporation. 2005. "The Economic Consequences of Firefighter Injuries and Their Prevention. Final Report." NIST GCR 05-874, National Institute of Standards and Technology, Gaithersburg, MD.
- WISQARS. 2019. Web-based Injury Statistics Query and Reporting System. Center for Disease Control. Available at: <https://www.cdc.gov/injury/wisqars/> Last Accessed 11 June 2019.
- Zhuang, J., V.M. Payyappalli, A. Behrendt, K. Luckasiewicz. 2017. "Total Cost of Fire in the United States." Fire Protection Research Foundation, Quincy, MA.