



The value of occupational health and safety data: Perceptions of current data practices in the fire service

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ABSTRACT

Objective: Despite growing interest in utilizing firefighter health and safety data to reduce injuries and fatalities, there is little evidence on attitudes towards data. We examined fire service perceptions of data to inform future policies and practices. **Methods:** We conducted focus groups and interviews with career firefighters, union representatives, and department leaders in Maryland and Virginia; and interviews with national leaders (March–November 2023). **Results:** We conducted 35 interviews and 4 focus groups (65 participants). Departments collected health, injury, and exposure information to establish fitness for duty, facilitate benefits, conduct prevention, and advance administrative priorities. Leaders described cultural and resource limitations. Participants desired more mental health and exposure data, and improved data infrastructure. **Conclusions:** Participants viewed data as valuable for health and safety but identified needs surrounding future data collection, resource investments, and cultural shifts.

1. Introduction

Researchers and leaders in the fire service have long called for improving the fire service's data reporting and analytic capabilities by collecting larger and more granular amounts of health and safety data (Averill et al., 2011). Leaders from the National Institute for Occupational Health and Safety (NIOSH) and the U.S. Fire Administration have highlighted the need for more information on injuries, exposures, and self-reported risk factors (Fent et al., 2023; Moore-Merrell, 2021). Firefighters have expressed concerns about high rates of injury, cardiovascular disease, mental health, and cancer (Fent et al., 2023; Moore-Merrell, 2021; Jahnke et al., 2012a). Improving occupational health and safety surveillance in the fire service could involve improving the level of detail in existing injury documentation or establishing new data surveillance efforts, such as documenting exposure data and establishing data linkages (Averill et al., 2011; Fent et al., 2023). It might also entail gathering new kinds of information, such as biometric data collected using wearable devices (Taborri et al., 2021; Grant et al., 2015).

Government agencies have begun to invest in infrastructure to

support firefighter injury surveillance. In 2023, the U.S. Fire Administration announced that it would transition its legacy incident reporting system, the National Fire Incident Reporting System (NFIRS), to a modernized analytics platform, the National Emergency Response Information System (NERIS) (Alexander et al., 2023). From a research standpoint, NIOSH recently launched the National Firefighter Registry for Cancer, which will link firefighter cancer diagnoses to state cancer registries (National Firefighter Registry, 2022). On a local level, departments are naturally positioned to collect data on their workforces that might be used to design and implement tailored interventions to reduce injuries and fatalities. There are a wide array of products (e.g. software platforms) for departments to track injuries or exposures, and growing calls for departments to leverage data (Moore-Merrell, 2021; NFORS, 2024).

Although these efforts have immense potential, data collection and reporting places administrative burdens on fire departments, often requiring manual data entry by firefighters who may lack the time, expertise, and motivation to conduct high quality documentation (Averill et al., 2011; Roman, 2024). NFIRS has been widely criticized for

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being difficult to use and for delayed data publication (Roman, 2024; NFIRS; Alexander et al., 2023; Kinsey & Ahrens, 2016). While fire departments and individual firefighters play a critical role in reporting injuries and fatalities, there is little evidence on how they perceive data and how, from their front-line perspective, they might suggest improving data reporting or utilization. To our knowledge, there are no studies assessing the current state of occupational health and safety data collection in fire departments, including perceptions of whether such data are adequate, and the challenges associated with collecting and managing these data. These kinds of insights could help inform the development of NERIS and other data initiatives designed to modernize and optimize the fire service's data infrastructure.

This study examined perceptions of current occupational health and safety data collection practices among career firefighters who might be asked to provide such data, and departmental and national leaders who might collect, access, or use such data. We were interested in understanding perspectives on the current state of fire department data practices and the implications of these findings for future data initiatives. We explored common data collection and use practices in fire departments in Maryland and Virginia, as well as national-level fire service organizations, and assessed the challenges and data gaps associated with firefighter health and safety.

2. Materials and methods

Because of the limited evidence on this topic, we conducted an exploratory study using qualitative methods to examine fire service stakeholders' perspectives on data collection practices.

2.1. Sample and recruitment

We identified three subgroups anticipated to have distinct views: career (e.g. "paid") firefighters, department leaders, and national-level fire service leaders. For career firefighters and department leaders, we first sampled departments, as we wanted to recruit firefighters and leaders within the same departments to enable comparisons. A member of the study team developed the Firefighter Organizational Culture of Safety (FOCUS) survey, which is used in practice settings to assess safety climate and its outcomes (Taylor et al., 2019). We sampled fire departments that participated in FOCUS assessments in Maryland and Virginia, recruiting two departments in each state (four total).

Within each fire department, we worked with a point of contact to recruit career, rank-and-file firefighters to participate in focus groups. In a Maryland department, where we were unable to recruit sufficient participants for a focus group (e.g., at least two participants), we conducted a semi-structured interview. To understand the role of unions in representing firefighters' interests, we also recruited union leaders in participating departments that were unionized to participate in semi-structured interviews. To recruit leadership participants within fire departments, we worked with a point of contact to identify individuals in overall leadership, health and safety, or in human resources (HR). We included these department-level leaders because they might access employee health and safety information as part of their work (health and safety and HR staff), and/or be responsible for guiding the department's health and safety initiatives (overall leadership, health and safety). We recruited both sworn members of the fire service and civilians (e.g. non-firefighters working in leadership in departments or fire service organizations) to participate in semi-structured interviews.

At the national level, we used purposeful sampling to identify participants in government, advocacy, and research organizations. For the national and department leadership interviews, we also conducted snowball sampling and asked participants to recommend potential participants in their professional networks.

2.2. Data collection

We sought participants' perceptions of current data practices in their organizations. This study was part of a larger examination of data privacy in the fire service; here we report findings on participants' views on data collection and data use, which are key components of data privacy frameworks (Richards, 2021). To facilitate comparisons across subgroups, we asked all participants about their views about data collection and use, but modified the questions slightly to recognize their different roles. We used English language semi-structured guides that covered several overarching topics and probed specific points as needed. We asked all participants demographic questions. For focus group participants, instead of asking demographic questions orally, we asked them to complete an exit survey at the end of the group to protect their confidentiality. Appendices 1–3 contain high-level discussion topics from the interview guides, the focus group discussion guide, and the exit survey.

Data collection took place from March to November 2023. All interviews were conducted over Zoom and all focus groups were conducted in person at fire stations. In the two Virginia departments, focus groups were held at fire stations while firefighters were on duty. In some groups, firefighters were taken out of service for the duration of the discussion, meaning that they were not responding to calls. In other groups, participants were in service and if they received a call during the discussion it was briefly paused or continued with the remaining participants until the full group rejoined.

Following each interview or focus group the interviewer wrote memos to summarize the discussion, reflect on themes, and document initial observations (Braun and Clarke, 2006). We obtained oral consent and audio recorded the interviews and focus groups. Recordings were transcribed verbatim using a professional transcription service. This research was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

2.3. Analysis

We conducted data analysis in an iterative fashion using thematic analysis (Braun and Clarke, 2006). One team member developed a codebook based on the memos and interview/discussion guides. A second team member reviewed the codebook after reading memos and transcripts. These team members independently double coded an initial subset of transcripts, met to compare consistency of coding, and resolved differences in code application. In instances when the coders applied different codes, they discussed the purpose behind each code and agreed upon the codes to apply, making changes to the definition of codes when necessary. After refining the codebook based on the initial round of coding, team members double coded additional transcripts to ensure consistent application of the finalized codebook. The two team members then independently coded the remainder of the transcripts, meeting regularly to discuss questions as needed. Coding was conducted in Dedoose (Dedoose Version, 2021).

Focus group and interview transcripts were analyzed concurrently. While analyzing our findings, we organized participants into two groups, with the first capturing views among firefighters (rank-and-file firefighters and union leaders) and the second capturing views among leadership (department leaders, government officials, advocates, and researchers). The participants within each group are conceptually similar and overall, we found similarities in views within each group. We note differences within the firefighter and leadership groups when relevant. When describing our results, we primarily compare views between firefighters and leadership. The coders determined saturation by assessing whether we were discovering new themes from the firefighter or leadership groups and confirmed saturation had been reached when we were no longer finding new themes. We present both themes that were expressed by large numbers of participants as well as themes that were raised by a smaller number of individuals but were consistently discussed and raised important insights.

3. Results

3.1. Sample

We conducted 35 interviews and 4 focus groups (of 5–9 participants each) for a total of 65 participants. Our sample included 31 career firefighters, 2 union leaders, 11 national leaders, and 21 department-level leaders. Table 1 shows participant breakdown by role and jurisdiction. Our firefighter sample is weighted towards Virginia, with 30 Virginia firefighters and 1 Maryland firefighter, due to data collection challenges in Maryland.

Our sample was predominately male and White, consistent with the overall demographics of the fire service (U.S. Bureau of Labor Statistics, 2024). Leadership participants included more women (34%) compared to firefighter participants (12%) and were more racially diverse (25% non-White compared to 9%). Leadership participants were older than firefighter participants (mean age of 48 years compared to 35 years) and more experienced (mean of 25 years compared to 12 years). Table 2 shows participant characteristics across subgroups. Focus groups lasted an average of 77 min. Firefighter interviews were an average of 39 min, and leadership interviews were completed in an average of 45 min each.

3.2. Themes

We identified four themes with nine subthemes: (1) current data collection; (2) the value of data in the fire service; (3) data challenges; and (4) priorities for addressing gaps in current practices. Table 3 shows the themes and subthemes and an overview by stakeholder group (firefighters and leadership).

3.3. Current data collection

Participants described four types of data that were routinely collected by their organizations.

3.3.1. Types of data collected

Leaders and firefighters within the same departments provided consistent descriptions of the types of firefighter health and safety information collected, although the depth and range of data collection varied across departments. Table 4 details the data collected in department and national third party organizations. All departments collected information related to firefighter injuries, exposure to occupational hazards, vital signs on a fireground, and regular physical exams. Three departments conducted regular fitness tests. Several department leaders and firefighters suggested that in some cases, departments intentionally avoided collecting or documenting sensitive information related to physical or mental health, to protect individual privacy and encourage firefighters to utilize services.

Government officials described routine collection of firefighter injury surveillance data, and researchers collected a range of injury and exposure information. For the most part, advocates did not directly obtain firefighter occupational health and safety data, although a few organizations helped facilitate research. Several advocacy participants

Table 1
Participant roles by jurisdiction.

	Virginia	Maryland	National	Total
Firefighters				
Career Firefighters	30	1	–	31
Union leaders	1	1	–	2
Leadership				
Department	7	14	–	21
Government	–	–	3	3
Advocacy	–	–	6	6
Research	–	–	2	2
Total	38	16	11	65

Table 2
Participant characteristics by role.

	Firefighters	Leadership
Gender n(%)		
Male	29 (88)	21 (66)
Female	4 (12)	11 (34)
Race n(%)		
White	30 (91)	24 (75)
Non-white	3 (9)	8 (25)
Age (mean years)	35	48
Experience (mean years)	12	25

Notes: One firefighter did not report age. Two leadership participants did not report years of experience.

Table 3
Overview of themes.

Themes	Firefighters	Leadership	Summary
Current data collection			
Types of data collected	X	X	Departments collected a range of health, injury, fitness, and exposure data. Government officials and researchers collected injury and fatality data.
Value of data in the fire service			
Establishing fitness for duty	X	X	Departments used medical, fitness information to establish fitness for duty status.
Obtaining benefits	X	X	Firefighters used injury, exposure information to facilitate workers' compensation, presumptive benefits.
Conducting health and safety prevention		X	Departments, researchers, and government officials used injury, health, fitness information to understand trends and design prevention.
Supporting administrative priorities		X	Leaders used data to obtain funding, advance diversity, equity, and inclusion priorities, and advocate for policy change.
Challenges			
Resource and logistical challenges	X	X	Firefighters and leaders described individual administrative burdens. Leaders described tech and resource challenges.
Cultural factors		X	Leaders encountered resistance to change, lack of emphasis on evidence, and skepticism about data integrity.
Priorities for addressing gaps			
New data collection	X	X	Firefighters and leaders called for more data in specific areas, such as mental health and exposures.
Strengthening data infrastructure		X	Leadership called for improved technology and data linkages.

Notes: An “X” indicates that this theme was raised by a stakeholder group. Blank cells indicate that this theme was not discussed.

Table 4

Types of data collected by departments and national organizations.

Type of data	Departments	National third parties
Injuries	All departments conducted injury reporting, collecting information about nature, cause of injury	Government officials and researchers conducted injury surveillance
Exposures	All departments collected some exposure data, with some focusing on emergency medical service exposures (e.g. needle stick) and others including fire-related exposures. Some only documented fire exposures that were perceived as particularly hazardous. A few departments described standardized hazmat exposure documentation	Some researchers collected exposure information
Fireground vital signs	All departments documented vital signs such as heart rate and blood pressure on a fireground (referred to as “rehab”)	N/A
Physical exams	All departments conducted an annual physical exam although the frequency and thoroughness varied. Some conducted in depth	N/A
Fitness tests	National Fire Protection Association (NFPA) 1582 physicals, and others required a civilian physical Three departments conducted regular fitness tests, with varying levels of intensity	N/A
Mental health information	Intentionally not collected due to the sensitivity of this information. Most departments did not document peer mental health support services	N/A
Underrepresented minority data	N/A	Some advocacy participants discussed research partnerships to examine issues affecting women or racial minorities, such as rates of harassment or discrimination or specific health outcomes

Notes: N/A signifies that participants either indicated that this type of data was not collected or this type of data was not mentioned during interviews or focus group discussions.

discussed research partnerships to examine issues impacting underrepresented minorities in the fire service.

3.4. Value of data in the fire service

Participants described four use cases for firefighter data: establishing fitness for duty, obtaining benefits, conducting health and safety prevention activities, and advancing administrative priorities.

3.4.1. Establishing fitness for duty

Both firefighters and leaders described the primary function of physical medical exam and physical fitness test data as establishing fitness for duty status. In cases where a firefighter did not pass a physical, they might be placed on light duty and perform limited job tasks, or be offered additional training.

3.4.2. Obtaining benefits

Participants across all stakeholder groups cited injury and exposure data as a tool for helping firefighters obtain workers' compensation or presumptive benefits to care for occupational injury or illness. Firefighters repeatedly highlighted the importance of documenting workplace injuries, even if minor, in case they needed evidence for a future workers' compensation case. Firefighters also noted that exposure documentation was increasingly essential for obtaining disability and retirement benefits, particularly for occupational cancers. Firefighters and leaders noted that despite presumptive benefit laws, which establish a list of cancers that can be “presumed” to be work-related for firefighters, many firefighters needed extensive documentation to establish an occupational cause of these diseases.

I think you see that [exposure documentation] more with prevalence of like cancers and stuff. Because it's like, I mean, they have like presumptive acts but still you kind of have to prove it still. So, having the [exposure] forms definitely are beneficial moving forward. – Firefighter 5, Focus Group

Although many firefighters described an antagonistic relationship with workers' compensation, noting that claims could be denied even with extensive documentation, they believed that it was still beneficial to record exposures.

3.4.3. Conducting health and safety prevention activities

Leadership participants were enthusiastic about using injury, fitness, and health data for prevention. Several departments had health and safety personnel that used these data to understand trends and design interventions. Participants agreed that the intent of health and safety staff was to understand and reduce injuries, although there were mixed views within and across departments about whether these efforts were effective.

So, on a departmental level, we use [injury and exposure information] to track trends and identify ... [I]f we have a bunch of people getting exposed to similar things, then that's a safety program focus. Or if we have injuries that are occurring in the same way, obviously there's probably some engineering controls that we can put in to reduce those injuries. – Department Leader 10, Interview

Government officials described using injury reporting data to uncover underlying causes of injury and fatality. Advocates, who were not necessarily directly involved in data collection or analysis, expressed support for injury and fatality research. A small number of leaders both in advocacy and departmental roles highlighted research studies that examined the health of underrepresented minorities:

We're really seeing that our Black members are having significantly higher specific cancer rates, and that's something where in our department, we can really push for some of the – like the educational efforts [to] really highlight that and why is that. – Advocate 4, Interview

3.4.4. Supporting administrative priorities

Leaders characterized data as a tool for achieving administrative priorities like obtaining funding, improving recruitment and retention, and enacting policy changes. Individuals in departments, advocacy organizations, and government described using data to justify purchasing new equipment, hiring personnel, or to link reductions in workers' compensation expenses to injury prevention efforts. Many leaders framed obtaining funding as one of their primary pathways for protecting their workforce:

I mean, I need the data to explain why I need money. Ultimately my job is to get money to buy my firefighters stuff to protect them, to take care of them. – Department Leader 5, Interview

3.5. Challenges

Despite the perceived value of data in the fire service, participants described significant data-related challenges. These included resource and logistical challenges and cultural factors.

3.5.1. Resource and logistical challenges

On an individual level, participants across stakeholder groups described challenges in collecting accurate and complete firefighter data. Firefighters primarily focused on administrative burdens of completing injury and exposure paperwork, which they viewed as time consuming and annoying. One firefighter said:

Don't get hurt. It's easier. Because it is—I mean, [injury reporting] it's like anything else. It's extra. You don't want to do it. Like it's aggravating.
– Firefighter 5, Focus Group

These frustrations were magnified by the perception that even after completing paperwork, their claims for workers' compensation could be denied. Firefighters also characterized exposure documentation as more burdensome than injury reporting. Many stated that their departments did not require consistent fire-related exposure documentation, and that they did not maintain personal records even though such information might be beneficial in the future.

Leaders in departments, advocacy, and research agreed that injury and exposure documentation burdens an already taxed workforce. Nearly all department leaders described challenges in collecting or analyzing existing data because of time, personnel, or funding limitations. Several participants noted that they simply lack the personnel or funding to conduct serious data collection or analysis. One chief explained:

For our department, it is lack of resources. Human capital and then technology. We're still working out of Microsoft Office products ... I think the barriers are really fiscal. –Department Leader 15, Interview

In other cases, leaders could access data but lacked the expertise, time, or software to use it. Two departments lacked software for injury documentation and analysis and were using paper forms or Excel. Departments also had difficulty linking datasets within their jurisdictions (e.g., with risk management) and aggregating data. On the national level, government, research, and advocacy stakeholders expressed similar frustrations regarding a lack of data linkages. Some pointed out that this prevented researchers from accessing data or increased administrative burdens on departments by requiring reporting to multiple sources. Participants believed these challenges prevented them from being able to see trends, understand causes, and react accordingly.

3.5.2. Cultural factors

Leaders were concerned about general apathy towards data in the fire service. Within departments, many leaders depicted their organization's posture towards data as outdated. National and department leaders suggested that the fire service as a whole did not value or prioritize data; many attributed this stance to a culture that prizes tradition and is resistant to change:

But as a culture, the fire service, we've been doing the same thing since we started, whether it's fire, rescue, or medical. The people aren't changing, they're just getting more of them and more of them. So, I think it would be a good push to move data collection, data utilization, and then policy changes to help move the entire industry forward. – Department Leader 8, Interview

Firefighters did not raise these types of industry-wide concerns and did not express opinions about their departments' culture towards data.

3.6. Priorities for addressing gaps in current practices

Participants identified areas for improvement in existing data

practices, including new data collection and strengthening data infrastructure.

3.6.1. New data collection

While some participants did not see any gaps in existing data practices, most described a wide array of opportunities where they believed additional data would enhance the use cases they articulated for existing data. Firefighters and leaders agreed on several priorities, but leaders identified a more extensive list of gaps.

There was widespread support for collecting more data on individual firefighters' exposures to help facilitate benefits. For instance, firefighters and leaders suggested that documenting every exposure to a fire scene would provide firefighters with evidence that potential illnesses were work-related:

I think what [Participant 5] said earlier, the exposure thing would be great if we could do probably more of that. Because everything we do now is tied to cancer. Everything we do. Even down to what we wear is proven to cause cancer. – Firefighter 8, Focus Group

Both leaders and firefighters highlighted the need for additional mental health data. Although mental health was not mentioned in all discussions, there was a general consensus that the fire service was trying to heighten attention on and services for mental health. A few leadership participants specifically called for additional data collection. One fire chief and several firefighters proposed an annual mental/behavioral health exam similar to an annual physical exam that could be used to establish fitness for duty and, if needed, connect firefighters with services.

Leaders of all kinds argued for more data on nonfatal injuries to better understand and prevent adverse events. Participants called for expanding the evidence base on the causes of injury, associated health risks or characteristics, and specific injury trends such as rising rates of violence against first responders. Some also noted rising awareness about occupational cancers and called for additional research, with almost all emphasizing the need for a basic understanding of cancer rates.

I know I can't have personal data on the medical information, but I'd like to know how many heart attacks we've had in this fire department. I'd like to know how many cancer cases we've had in this fire department. Because then that will help me go to bat for more cardiac programs, more prevention programs on this. – Department Leader 14, Interview

Many department leaders desired more fitness information, including general fitness statistics, an incumbent fitness exam (in departments where this did not already exist), or exercise logs. Leadership anticipated using these data to pinpoint areas of weakness across the department and implement training programs. A small number of firefighters in one focus group shared this view and criticized existing fitness exams as insufficient for capturing fitness for duty. A few leaders in departments and research organizations also called for biometric information from wearable devices worn on a fireground.

A small number of participants, largely in advocacy and senior leadership positions in departments, saw a need for more data on the experiences of underrepresented minorities. Advocates called for establishing baseline statistics on representation of women and racial minorities, and research on discrimination against these groups. Others called for additional research on the impacts of firefighting on women's reproductive health, both for prevention and to increase the evidence base for presumptive cancer policies. One female firefighter noted that the lack of evidence on female firefighters has far reaching impacts:

I can remember sitting and having a discussion with a bunch of the ladies I work with that, oh, we tend to have more shoulder injuries because they set up the cabinets in the apparatus for somebody who's six two, not somebody who's five four. Things like that. We work a lot more overhead. And I don't know how much in the department they're looking at age,

height, gender specific, how they're sorting that data ... – Firefighter, Interview

3.6.2. Strengthening data infrastructure

Several leaders indicated that even if data were theoretically available, they encountered challenges accessing or utilizing information. For instance, some individuals noted that injury data were collected by various entities with different reporting guidelines and there were no data linkages. In other cases, department leaders wanted software to assist with collecting or analyzing their health and injury data:

We have access to most of the stuff that we need. What we don't have currently is a way to really look at that and a way to really aggregate that ... we have not really found a product out there that has fulfilled our need for this. And really kind of gives us a snapshot at root causes. – Department Leader 16, Interview

Examples of desired technology ranged from injury tracking software to sophisticated wearable devices or dashboards that could be used on firegrounds. While firefighters were less attuned to the technological infrastructure that might enable new data collection, a few noted that automating data collection could help document exposures (e.g., if the call system automatically documented who responded to a fire call).

4. Discussion

This study examined current data practices in the fire service and career firefighter and leadership perspectives on the benefits, challenges, and shortcomings of existing data efforts across two states and within a national context. Our findings confirm that leadership and firefighters are generally supportive of efforts to expand health and safety data collection and offer new insights on the types of data they find useful and the barriers they face in collecting or using such data (Moore-Merrell, 2021; National Firefighter Registry, 2022; Widman et al., 2018; About the National Emergency Response Information System (NERIS), 2023). Participants highlighted the value of existing data and opportunities for the fire service to strengthen its data capabilities in pursuit of a healthier and safer workforce. Although participants sometimes characterized data as a challenging or complicated asset, overall we found that data were highly valued. While there were some differences in the level of detail or manner in which departments collected data, they were aligned in trying to document health and injury information to benefit firefighters. Nearly all leadership participants viewed data as a powerful but underutilized tool for helping keep firefighters fit for duty, healthy, and safe. And while firefighters identified fewer use cases, they noted the potential for data to aid them on an individual level when filing for benefits. While there is little research examining views towards occupational health and safety data, these findings are consistent with long-running calls for improved occupational injury surveillance and offer insights on views towards occupational health and safety data in one sector (Baker, 1989; Wolfe & Fairchild, 2010).

Our findings revealed complex motivations behind the desire for additional mental health and exposure data and highlighted potential challenges that might accompany this kind of data collection. Many leaders and firefighters identified the need for additional exposure and mental health data collection, consistent with prior research on firefighters' health concerns and calls for research on cancer and mental health (Jahnke et al., 2012a; Laroche & L'Espérance, 2021; Stanley et al., 2015; U.S. Fire Administration hosts, 2023; Vargas de Barros et al., 2013). Firefighters wanted more exposure data so that they could have detailed career exposure logs that would help them obtain benefits if they developed cancer. However, they also highlighted the current lack of convenient and systematic mechanisms for recording this type of information. Their descriptions of the value of exposure data reflects a disconnect between the purpose of presumptive benefit laws and the

burdens firefighters face in filing for these benefits. Presumptive benefit laws designate specific health outcomes that are presumed to be work-related, and are intended to ease the process of filing for workers' compensation coverage (Forrest, 2016). However, the firefighters in our sample indicated that they still require significant documentation of exposures that firefighters may not have at their disposal. Future reforms to these laws should account for the availability of exposure data to ensure that proving an occupational cause is not overly burdensome.

Our findings also offer insights on the complexities fire departments may face in evaluating their firefighters' mental health. Researchers and national leaders have called for research on the impacts of firefighting on mental health outcomes, and identified a need for department-level interventions to assess mental health risks and prevent suicide (Stanley et al., 2015; Vargas de Barros et al., 2013; Jahnke et al., 2014; Harvey et al., 2016). This aligns with broader occupational health and safety research, which has identified some promising mental health interventions but largely concludes that more interventions, and rigorous evaluation of these interventions, are needed (LaMontagne et al., 2014; Axén et al., 2020). The firefighters and leaders in our sample argued for additional mental health data collection within fire departments, both to evaluate fitness for duty and to help connect firefighters to services. However, we also discovered that mental health information is viewed as highly sensitive, and collecting this data may prompt privacy concerns. Department-led efforts to address mental health could provide firefighters with essential supports, but if firefighters are not comfortable sharing mental health information, these interventions will not be successful. Studies in other settings have found that employees across sectors are reluctant to disclose mental illness at work, but there is little evidence on how to facilitate occupational mental health interventions while navigating these concerns (Brohan et al., 2012; Bonaccio et al., 2019). More research is needed to explore data privacy preferences in the fire service, particularly around sensitive subjects such as mental health and behavioral health.

Only a small portion of our sample discussed using data to understand the experiences of women and racial minorities, but they suggested there are significant opportunities to collect data in support of a more diverse and inclusive fire service. Researchers have begun to examine outcomes specific to women in the fire service—for example, fitness, tobacco and alcohol use, reproductive health (e.g., rates of miscarriage), and harassment (Jahnke et al., 2012b; Yoder & Aniakudo, 1996; Jung et al., 2021; Jahnke et al., 2019). However, researchers, as well as some leaders in our sample, have noted that the small sample size of women in the fire service often leads to their exclusion from studies (Jahnke et al., 2012b). Departments and researchers should build upon this work to examine recruitment and retention trends, assessing whether women or racial minorities have differential experiences in the recruitment pipeline, why they leave the profession, and the health outcomes they experience.

These kinds of data gaps will be difficult to address without proper data infrastructure. Previous work has identified challenges with national- and state-level data infrastructure, but our research uncovered department-level challenges (Kinsey & Ahrens, 2016; Widman et al., 2018; Kahn & Mosier, 2018). Some departments still rely on paper forms or do not have staff who are able to conduct data analyses, rendering any data collected essentially unusable. Without the technology and personnel to effectively analyze injuries or fitness statistics, fire departments will be unable to develop prevention activities tailored to their workforces.

Insights derived from data are only as good as the quality of data collected. Firefighters and leaders alike acknowledged that data entry is a burdensome task, and leaders noted that this often resulted in poor quality data. Leaders also described cultural apathy towards data, which might contribute to data quality challenges. There may be opportunities to leverage technology to automate data collection and ease administrative burdens. For example, there are resources for individual firefighters to document their exposures through mobile apps (NFORS,

2024). On an organizational level, departments might be able to conduct some automation through their computer aided dispatch systems, which could provide logs of exposure to structure fires based on call history. With the launch of NERIS, the U.S. Fire Administration is developing a modernized, national data infrastructure that could provide departments with the data structure needed to assess health and safety data. Our findings emphasize the importance of ensuring that NERIS is easy to use, requires low levels of data input from firefighters, and relies on automation as much as possible. Fire service leaders could also glean insights from other industries that have sought to improve injury surveillance, such as the agriculture sector, which has attempted to develop sector-specific surveillance databases and cost effective strategies for maintaining high quality data (Scott et al., 2022; Scott et al., 2021).

Ultimately, many of the challenges participants described stemmed from monetary constraints. Most fire departments are publicly funded organizations and leaders described serious funding challenges. It will be difficult for fire departments to justify investments in data collection and analytics if they are struggling to recruit and retain firefighters or purchase new PPE. Many leaders also commented on a general apathy towards data in the fire service, which may discourage investments in data infrastructure. However, researchers can play a role in helping departments justify the expenses associated with health and safety data. Research suggests that every firefighter injury results in tens of thousands of dollars in associated costs, and experts have linked occupational injury prevention with large financial savings (Butry et al., 2019; Bushnell et al., 2022; Business Case for Safety and Health, 2024). Researchers should partner with departments to assess the potential savings associated with injury reduction and rehabilitation programs as this evidence would help departments justify and advocate for investments in injury tracking software or additional health and safety personnel. Researchers can also play a role in helping departments collect or make sense of existing health and safety data. Firefighters and leaders voiced support for research on a wide array of health trends within the fire service. While there is a role for ongoing injury surveillance and regular health and fitness measurements within departments, researchers can lend their expertise on discrete projects related to a topic or help establish data infrastructure.

Finally, while leaders in our sample characterized the fire service as apathetic towards data, they simultaneously endorsed the value of data and called for collecting more and higher quality data. This may reflect the nature of our sample, as departments and individuals that agreed to participate may be more likely to value data. It might also reflect cultural shifts in the fire service. National-level data initiatives like NERIS and the National Firefighter Registry present an opportunity to conduct education on the importance of health and safety data for understanding and preventing injury and fatality. Organizational-level leaders can contribute to this shift by highlighting the importance and ultimate impact of data when asking firefighters to complete onerous data entry tasks like exposure documentation.

Our study has several limitations. We encountered recruitment challenges in Maryland that limited the size of our firefighter sample. We were unable to conduct focus groups while firefighters were on duty, as in Virginia, and could not recruit sufficient firefighters for a focus group and thus conducted an interview instead. While we found similar results across Maryland and Virginia, and similarities among firefighters and leadership in Maryland, we may have identified a broader range of opinions in a larger sample. Our sample excluded volunteer firefighters, who represent approximately two thirds of the firefighters in the United States, because we were focused on understanding views towards data in occupational settings (Fahy et al., 2022). Because this is a qualitative study, our findings are specific to the geographic jurisdictions and departments that we worked with but are informative for hypothesis generation in the fire service broadly. Because fire departments were recruited through study team networks, they had a history of participating in research. Data practices and attitudes towards data might differ across departments and regions, and future research should

examine this topic across a more diverse sample.

Our findings reflect optimism about the role of data in protecting firefighter health and safety alongside frustration about the lack of resources for high quality data collection and analysis. Participants identified specific data gaps, funding challenges, technological priorities, and cultural shifts needed to maintain a fit workforce, process firefighter benefits, and enable injury prevention programs. These findings can inform ongoing efforts to modernize the fire service's data infrastructure and conduct research on firefighter health and safety.

CRedit authorship contribution statement

Rachel J. Topazian: Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Aleksandra Wec:** Writing – review & editing, Formal analysis. **Joseph Ali:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Shannon Frattaroli:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Paul Locke:** Writing – review & editing, Supervision, Conceptualization. **Jennifer A. Taylor:** Writing – review & editing, Methodology, Conceptualization. **Cassandra K. Crifasi:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jsr.2025.06.016>.

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