Firefighter Injuries Relative to Fire Response Characteristics

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Executive Summary

Firefighters perform physically demanding work while providing essential services to support the health and wellbeing of our communities. Firefighting tasks often expose firefighters to workplace factors that are associated with injury and illness. In particular, fire suppression activities have been linked with higher physical demands and higher injury rates. Although previous research has identified the burden of injury in firefighting, less clear is the impact of fire suppression tasks on firefighter injury. Furthermore, reported firefighting injury characteristics are often reflective of specific regional contexts and are less responsive to the national trends in injury data.

Thus, our study used data from the National Fire Information Database (NFID) to identify the types of injuries experienced and the relationship between the injury type and the fire response context. Our analysis focused on professional firefighters as the strategies, policies and implementation mechanisms for prevention and rehabilitation of injury are expected to differ between professional and volunteer firefighters. A primary difference is that professional firefighters can access benefits provided through provincial workers' compensation boards (WCBs), which are not available to volunteer firefighters. Our study findings are intended to inform the development of evidence-based injury prevention strategies targeted towards reducing the personal and occupational burden of professional firefighter workplace injury and illness.

Our analyses identified that:

- 2,025 injured firefighters had an average of 14 years of service experience; the majority were middle aged (31-45 years) and older (≥46 years) males with a body mass index of 27.3 kg/m^2.
- Over 80% of injuries reported were categorized as "minor" (injuries requiring less than 1 day off work and / or in hospital); less than 20% were categorized as "serious" (injuries requiring 16+ days off work and / or hospitalization for 3+ days).
- The most frequent reported injury type was 'injury to muscle, ligaments, joints' (45%) and injury location was the 'head, neck or spine' (11%).
- Initial and subsequent (final) crew size were lower for injuries characterized as "serious" versus "minor".
- We attempted to identify the relationship between personal protective equipment (PPE) use and firefighter injury severity (length of absence from work); the results were inconclusive.

Improving our understanding of injury characteristics relative to fire suppression characteristics such as crew size and personal attributes, years of service and age, provides unique insights into injury mechanisms that will be critical to informing development of injury prevention strategies for firefighters in Canada. Improving data collection methods particularly related to injury type, injury location and use of PPE will enhance our ability to understand the unique contribution of these factors associated with firefighter injury.

Problem Statement

Our overarching objective was to determine the relationship between specific fire response characteristics (e.g., firefighter personal attributes, personal protective equipment, action taken to manage the fire) and firefighter injuries (i.e., cause, type) in Canada. The specific questions that guided our analyses included:

i.) What are the firefighter injury characteristics including injury type, injury location, and length of absence from work associated with injury?
ii.) How do firefighter personal attributes (i.e., height, weight, years of service) relate to firefighter injury?
iii.) Does firefighter personal protective equipment (i.e., helmet, gloves, coat, face shield) worn during emergency response impact firefighter injury cause and type?
iv.) Do fire response characteristics (i.e., crew size, number of victims) impact firefighter injury?
v.) Does geographical placement of the fire service impact firefighter injury cause and type?

Introduction

Firefighting is a high-risk occupation responsible for numerous occupational injuries, diseases and disorders (1–9). In comparison to other occupations, firefighters experience high rates of musculoskeletal (MSK), burn, and inhalation injuries and high rates of occupational diseases including cancers, respiratory diseases, and post-traumatic stress disorder (1–9). Injuries often occur during fire suppression and training activities and from cumulative exposures to high physical demands. Additionally, firefighters' work tasks, work organization and work environments influence their health and work. For example, firefighter tasks are intermittently physically demanding which increases the risk of injury and illness to the cardiovascular and musculoskeletal systems (4,7,9). A comparative study between firefighters and office workers in the same fire department identified that firefighters experienced higher rates of musculoskeletal disorders, cardiovascular disorders, fatigue and sleep disorders (1). High physical demands exerted on both the musculoskeletal and cardiovascular systems were identified as likely factors contributing to these adverse occupational health responses. Furthermore, a 2015 Canadian study determined that 64% of firefighter injuries are musculoskeletal sprains and strains (10). In the context of musculoskeletal disorders, 33% of firefighter injuries were related to low back disorders and 89% were related to upper and/or lower limb musculoskeletal injury (11).

The burden of injury associated with firefighting activities suggests that developing and implementing strategies to reduce exposure to injury risk factors associated with firefighting is required to ensure the longevity of firefighters' health and wellbeing and improve firefighter safety. The overarching purpose of this study was to identify the types of injuries experienced by professional firefighters across Canada and to identify whether personal attributes (i.e., height, weight, years of service) and fire response characteristics (i.e., crew size, use of personal protective equipment) are related to the length of disability resulting from the injury (injury severity).

Methodological Approach

PARTICIPANTS

Using the National Fire Information Database (NFID), we selected full-time (professional) firefighters who were classified as victim between 2005 and 2014. A victim was an individual who experienced an injury during an event reported to the NFID. Victims who were not firefighters (n=11,834) and firefighters with part-time, volunteer, or unknown status (n=1,467) were excluded from our study. Thus, our analysis included 2,025 professional firefighters who sustained an injury (i.e., victim) and was reported to the NFID.

Secondary data analysis involves some uncertainty about data quality and the inability to recheck values from the original database. Therefore, to optimize data quality a series of validity checking decisions were implemented. Firefighters' (n=2,025) data were limited to those aged 20 to 65 years to a valid range of ages. Valid values for height and weight were set to range between 150 to 215 cm and 50 to 150 kg, respectively. Body mass index (BMI; kg/m^2) was calculated for all firefighters with non-missing height and weight. To reflect the firefighter age range, the maximum years of service was set at 45 years. Unknown values for age, sex, height, weight, and years of service characteristics were set to missing.

INJURIES

Firefighter victims reported one injury per incident within the NFID. Injury severity was defined as minor if it resulted in <1 day in hospital or <1 day off work, light injuries resulted in 1-2 days hospitalization and/or off work for 1-15 days, and serious injuries resulted in ≥3 days hospitalization and/or ≥16 days off work.

Injury types were defined by the following categories: 1) head, neck, spine injury; 2) wounds, punctures, lacerations; 3) heart attack, stroke; 4) bone injury or fracture; 5) asphyxia, respiratory condition; 6) injury to muscle, ligaments, joints; 7) heat illness, cold exposure, fatigue; 8) minor cuts, bruises; and 9) other injuries. The category of "Other" included injuries such as burns, scalds, eye injuries, and traumatic shock, which were not a primary interest for our analyses.

FIREFIGHTER PERSONAL PROTECTIVE EQUIPMENT (PPE)

We considered all available personal protective equipment (PPE) data for our analysis, which included helmet, helmet line, face shield, other eye protection, coat, gloves, boots, breathing apparatus and hose key belt. All PPE values that were unknown were set to missing.

FIRE RESPONSE CHARACTERISTICS

We used crew size, final crew size and the number of victims and number of deaths to identify the impact of fire response characteristics on firefighter injury and length of absence from work (injury severity). We were also interested in determining the number of engines per incident involving firefighter victims and the method of fire control and extinguishment. Values that were unknown were set to missing.

GEOGRAPHICAL PLACEMENT

We did not exclude jurisdictions from our analysis. We included all provinces and territories with full time, professional firefighter victim (injury) data.

Results

PARTICIPANT CHARACTERISTICS

Participants were 2,025 full-time firefighters (1826 men, 36 women, 163 unknown) with injuries (victims) reported in the NFID between 2005 and 2014. Age was reported for 913 firefighters, height was reported for 594 firefighters, and weight was reported for 601 firefighters. Overall, mean age of the firefighters was 42 (± 8) years and mean years of service was 14 (± 9) years (see Table 1). Fifty one percent of firefighters were considered middle-aged. The average BMI was 27 (± 4) kg/m^2; 75% of firefighters were considered overweight or obese (see Table 1).

TABLE 1. CHARACTERISTICS OF FULL-TIME FIREFIGHTER VICTIMS, NATIONAL FIRE INFORMATION DATABASE 2005 – 2014

	TOTAL (N = 2,025)
Firefighter Characteristics	Mean ± SD or n (%)
Years of Service	14.4 ± 8.6
Sex (% female) [a]	36 (2%)
Age (years)	41.9 ± 8.4
Age groups (%) [b]	
Young (30y and younger)	109 (12%)
Middle Aged (31 to 45y)	466 (51%)
Older (46y and older)	338 (37%)
Height (cm) [c]	179.1 ± 7.8
Weight (kg) [d]	87.4 ± 11.2
Body mass index (kg/m^2) [e]	27.3 ± 3.6
Body mass index groups (%)	
Normal (<25kg/m^2)	146 (25%)
Overweight (25-30kg/m^2)	328 (57%)
Obese (≥30kg/m^2)	104 (18%)

[a] Sex unknown for n=163
[b] Values represent n=913, all others missing
[c] Values represent n=594, all others missing
[d] Values represent n=601, all others missing
[e] Values represent n=578, all others missing

INJURY CHARACTERISTICS: INJURY TYPE, INJURY LOCATION AND LENGTH OF ABSENCE FROM WORK

Table 2 shows the distribution of firefighter injuries, according to severity and type. Overall, the most common types of injuries were those related to muscle, ligaments, or joints (45%) and head, neck, or spine (11%). Of the injuries reported to the NFID, 1585 were identified as minor (requiring less than 1 day off work / in hospital) and 312 were identified as serious (requiring 16+ days off work or in hospital).

TABLE 2. DISTRIBUTION OF FULL-TIME FIREFIGHTER INJURY SEVERITY AND TYPE, NATIONAL FIRE INFORMATION DATABASE 2005 – 2014

Injury Characteristics	**TOTAL** (N = 2,025) n (%)
Severity of Injury	
Minor	1585 (84%)
Serious	312 (16%)
Type of Injury	
Muscle, ligaments, or joints	752 (45%)
Head, neck, or spine	188 (11%)
Minor cuts or bruises	145 (9%)
Wounds, punctures, or lacerations	117 (7%)
Heat illness, cold exposure, or fatigue	95 (6%)
Bone injury or fracture	88 (5%)
Asphyxia/respiratory condition	83 (5%)
Heart attack or stroke	11 (1%)
Other	202 (12%)

Note: Injuries where the severity or type was unknown were excluded from the calculation of percentages

Table 3 shows the impact of work absence (injury severity – minor injuries compared to serious injuries) on distribution of firefighter injuries, according to severity and type. When stratified by injury severity, firefighters with slightly longer years of service reported more serious injuries (requiring longer work absences). Overall, the distribution of injury type (injury to muscle, ligaments or joint) and injury location (head, neck, or spine) remained the same.

TABLE 3. CHARACTERISTICS OF FULL-TIME FIREFIGHTERS, INJURIES, AND INCIDENTS ACCORDING TO SEVERITY OF INJURY

Firefighter and Fire Response Characteristics	MINOR INJURIES (N = 1334)	SERIOUS INJURIES (N = 276)
	Mean ± SD or n (%)	Mean ± SD or n (%)
Years of Service [a]	14.2 ± 8.6	15.4 ± 8.3
Age (years) [b]	41.6 ± 8.4	42.6 ± 8.4
BMI (kg/m^2) [c]	27.4 ± 3.5	27.0 ± 3.8
Injury type		
Muscle, ligaments or joints	601 (45%)	107 (39%)
Head, neck, or spine	143 (11%)	35 (13%)
Minor cuts, bruises	135 (10%)	9 (3%)
Wounds, punctures, or lacerations	103 (8%)	12 (4%)
Heat illness, cold exposure or fatigue	67 (5%)	23 (8%)
Bone injury or fracture	46 (3%)	40 (14%)
Asphyxia/respiratory condition	68 (5%)	11 (4%)
Heart attack or stroke	2 (<1%)	8 (3%)
Other	169 (13%)	31 (11%)
Incident characteristics [d]		
Crew size	2.3 ± 2.7	1.6 ± 2.1
Subsequent crew size	21.3 ± 48.7	14.3 ± 27.4
Total number of persons injured	1.5 ± 1.4	1.6 ± 1.2
Total number of casualties	1.5 ± 1.4	1.7 ± 1.2

[a] Years of experience unknown for n=862 firefighters with minor injuries, n=121 firefighters with serious injuries
[b] Age unknown for n=863 firefighters with minor injuries, n=122 firefighters with serious injuries
[c] Body mass index unknown for n=1109 firefighters with minor injuries, n=210 firefighters with serious injuries
[d] Characteristics unknown for n=428 incidents related to minor injuries, n=70 incidents related to serious injuries

INJURY CHARACTERISTICS: IMPACT OF PERSONAL ATTRIBUTES ON INJURY SEVERITY AND TYPE

We stratified by age group to compare injury characteristics in younger versus older firefighters (see Figure 1). Younger firefighters reported more incidents of 'wounds, punctures, lacerations', 'asphyxia, respiratory conditions' and 'minor cuts and bruises' than middle-aged and older firefighters. Further, injuries to muscles, ligaments, or joints were fewer among the young firefighters compared to the older firefighters (36% vs. 47%). Injuries to muscle, ligaments and joints was the most frequently reported injury type across all age groups.

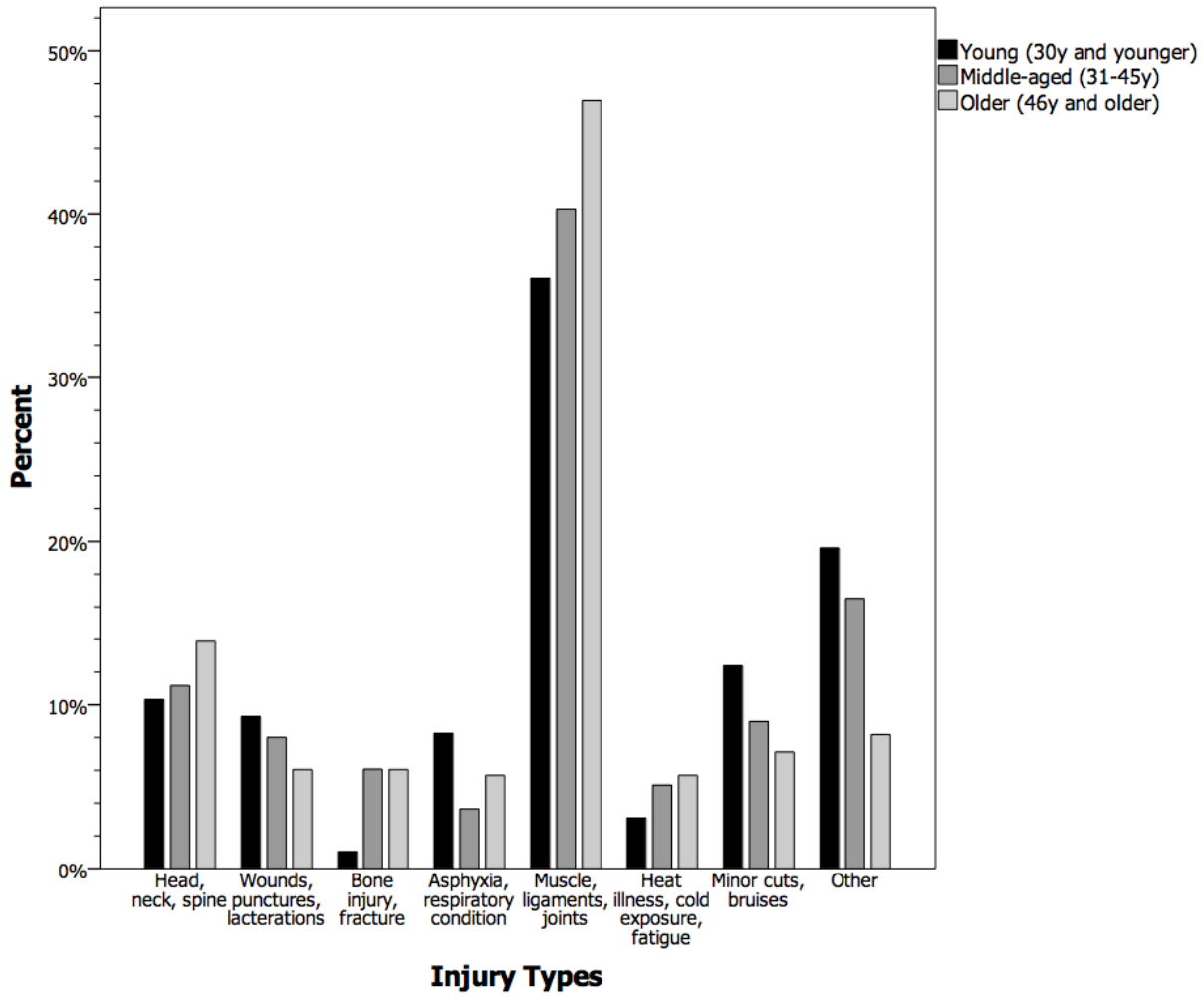

FIGURE 1. TYPES OF INJURIES REPORTED IN THE NFID BY FULL-TIME FIREFIGHTERS (2005-2014) ACCORDING TO AGE GROUP. ALL BARS REPRESENT PERCENT OF TOTAL INJURY CASES WITHIN SPECIFIED AGE GROUP.

PERSONAL PROTECTIVE EQUIPMENT: IMPACT ON LENGTH OF ABSENCE FROM WORK

Table 4 shows that firefighters reported wearing their personal protective equipment; there are more reports of PPE usage when firefighters report a minor injury versus a serious injury. The helmet was the most frequently worn PPE component when experiencing a minor injury; boots were the most common PPE component worn when reporting a serious injury. The hose key belt was the least frequent PPE component worn when reporting either a minor or a serious injury.

TABLE 4. PROTECTIVE EQUIPMENT WORN BY FIREFIGHTERS AT TIME OF INJURY, ACCORDING TO SEVERITY OF INJURY

Personal Protective Equipment	MINOR INJURIES (N = 1585)	SERIOUS INJURIES (N = 312)
Helmet	1446	295
Boots	1438	299
Coat	1421	288
Helmet line	1421	287
Gloves	1378	289
Face shield	1237	263
Breathing apparatus	1069	223
Other eye protection	686	123
Hose key belt	117	20

Note: All protective equipment cell values represent 100% of non-missing data

FIRE RESPONSE CHARACTERISTICS AND FIREFIGHTER INJURY SEVERITY

Table 3 shows that the average number of injuries per incident was 1.5 (± 1.4). Crew size ranged from 1 to 29 and subsequent crew size ranged from 2 to 1277. The number of persons injured, and the number of casualties were marginally lower during incidents that resulted in minor injuries compared to serious injuries.

Table 5 shows that the highest number of minor injuries were reported when a smoke alarm location was unknown, and the status of the smoke alarm was unknown; the fewest number of firefighter injuries were reported when a smoke alarm was active and when a smoke alarm wasn't applicable (i.e., during a medical only response call).

TABLE 5. CHARACTERISTICS OF SMOKE ALARM DEVICE PERFORMANCE ACCORDING TO INJURY SEVERITY REPORTED BY FULL-TIME FIREFIGHTERS [a]

Smoke Alarm Device Performance	MINOR INJURIES (N = 1585) n (%)	SERIOUS INJURIES (N = 312) n (%)
No smoke alarm	172 (15%)	21 (9%)
Alarm in room of origin, Activated	170 (15%)	39 (16%)
Alarm in room of origin, Not Activated	111 (10%)	13 (5%)
Alarm location unknown	212 (18%)	58 (24%)
Alarm activation unknown	386 (33%)	92 (38%)
Not applicable	106 (9%)	18 (7%)

[a] Alarm performance unknown for n=627

Note: Injuries where the severity or type was unknown were excluded from the calculation of percentages

The highest total number of injuries (i.e., civilian or other emergency response personnel) was associated with firefighters reporting asphyxia or respiratory distress; the lowest total injuries was associated with firefighters' injuries of minor cuts and bruises (Table 6). Firefighters experienced longer absences from work (injury severity) when the total number of injuries incurred during an emergency response was highest (see Table 6). With a total of 19 deaths, mean number of associated firefighter injuries was very low. An overall decline in total deaths resulting from fire incidents is in line with previous NFID reports (12). As a result of missing and unknown data, we were unable to report about the number of engines and the method of fire control and extinguishment as they relate to full-time, professional firefighters' injuries.

TABLE 6. MEAN NUMBER OF OVERALL INJURIES AND DEATHS REPORTED FOR FIRE INCIDENTS, ACCORDING TO FIREFIGHTER INJURY TYPE AND SEVERITY [a]

	TOTAL INJURIES (any) (N = 2156)	TOTAL DEATHS (any) (N = 19)
Firefighter Injury Characteristics	Mean ± SD	Mean ± SD
Injury severity [a]		
Minor	1.52 (± 1.42)	0.01 (± 0.18)
Serious	1.64 (± 1.19)	0.02 (± 0.13)
Injury type		
Head, neck, or spine	1.55 (± 1.02)	0.04 (± 0.43)
Wounds, punctures, or lacerations	1.58 (± 0.97)	0
Heart attack or stroke	1.62 (± 0.74)	0
Bone injury or fracture	1.44 (± 0.88)	0.03 (± 0.17)
Asphyxia/respiratory condition	2.27 (± 3.00)	0
Muscle, ligaments or joints	1.40 (± 0.83)	0.01 (± 0.11)
Heat illness, cold exposure or fatigue	1.62 (± 1.05)	0.02 (± 0.12)
Minor cuts, bruises	1.37 (± 0.84)	0.01 (± 0.09)
Other	1.54 (± 1.20)	0.01 (± 0.12)

[a] Injury severity unknown for n=95; injury type unknown for n=230

GEOGRAPHICAL PLACEMENT OF FIRE SERVICE

We found that incidents and victims in our analyses represented only Ontario. Although each jurisdiction reported incident and victim information to the NFID, with the exception of Canadian Armed Forces, our interest in professional firefighters excluded jurisdictions that did not report on firefighter status. Ontario was the only province to indicate employment status (full time, volunteer, or not applicable) within the victim database. Consequently, we are unable to comment on the variation in injury distribution across fire services in Canada due to limitations in jurisdictional reporting.

Discussion

OVERVIEW

Injury characteristics among professional firefighters were identified and the way in which personal attributes, fire response characteristics and geographical region impacted severity was also determined. Our analyses and interpretation are somewhat limited by the oversampling of data from Ontario and as well, the way that injury data appear to be reported. For example, is it challenging to identify how multiple injuries would be coded and further, body location of injury type would also be beneficial. Regardless, our results provide important insights into firefighter injury severity (the length of time firefighters are absent from work following injury) and the impact of fire response characteristics on injury severity.

Our findings suggest that professional firefighters who reported injuries to the NFID were 98% male, 42 years of age and had 14 years of service. The injuries reported by professional firefighters were primarily minor (requiring less than 1 day off work / in hospital) and 50% represented a range of musculoskeletal (MSK) injuries (muscle, ligaments and joints and bony injury / fracture). When stratifying injury type by injury severity (length of time away from work), injuries sustained to muscle, ligaments or joints remained the most frequent. Firefighters who reported serious injuries (requiring 16+ days off work or in hospital) also had slightly more years of service and were slightly older than the cohort who reported minor injuries (requiring less than 1 day off work / in hospital).

Analysis of fire response characteristics suggest that smaller initial and subsequent crew sizes were reported when injuries that resulted in longer absences from work were also reported. The number of persons injured as well as the number of casualties were also higher when firefighters reported more serious injuries. Smoke alarm operations also appears to be linked to injury severity; there appears to be a higher reporting of more serious injuries (requiring 16+ days off work or in hospital) when the status of a smoke alarm is unknown.

When considering the relationship between all injuries experienced (firefighter in addition to civilian and / or other emergency response personnel), a higher frequency of total injuries reported during the fire response event were associated with asphyxia and / or respiratory condition compared to other types of injuries.

FIREFIGHTER PERSONAL ATTRIBUTES AND FIREFIGHTER INJURY SEVERITY AND TYPE

Findings:

- Professional firefighters who reported an injury to the NFID following a fire response activity were male (98%), reported 14 years of service, were 40 years of age, and reported height and weight that resulted in a BMI of 27.3 $kg.m^2$ which places this cohort of firefighters in the “overweight” classification (13). Note the BMI has limitations as a measure of body composition; we are unable to differentiate weight from adipose tissue from the current database.
- 1.5 injuries were reported per firefighter, per reported fire response event.

- 84% of injuries reported by professional firefighters were classified as minor severity (requiring less than 1 day off work / in hospital); 16% were serious (requiring 16+ days off work or in hospital).
- Injury severity (Appendix A) and reported musculoskeletal injuries (Appendix B) show an overall decline between 2005 and 2014.
- Injury types reported by firefighters were primarily to the musculoskeletal system (50%), even when stratified by injury severity (length of absence from work).
- Firefighters with 15 years of service and were 43 years of age reported serious injuries (requiring 16+ days off work or in hospital) whereas firefighters with 14 years of service and were 42 year of age reported minor injuries (requiring less than 1 day off work / in hospital)
- A longer absence from work appears to be associated with 'head, neck or spine', 'heart attack or stroke', 'bone injury or fracture' and 'heat illness, cold exposure or fatigue'.
- Young (30 years and younger) firefighters also were found to report more 'wounds, punctures, lacerations', 'asphyxia, respiratory condition' and 'minor cuts, bruises' than middle-aged (31-45 years old) and older (46 years and older) firefighters.

Implications:

- These findings support our previous work (11) in a southwestern Ontario fire service that demonstrated firefighters who were 42 years of age and older and those with 15 years and more of experience reported more musculoskeletal complaints.
- Although injuries to the musculoskeletal system have declined since 2005 (see Appendix B), the frequency remains high; this suggests that there is a need to continue to develop and implement targeted interventions to reduce exposure to MSK risk factors and subsequently, reduce MSK injuries may reduce personal, occupational, and societal impact of injuries.
- Stratifying injury type by age provided initial insights into the types of injuries reported by firefighters. It seems that younger firefighters experience injuries that may be more readily preventable; the higher frequency of reporting respiratory conditions requires further investigation.
- Furthermore, it may be appropriate to target interventions that address muscle strength, muscle endurance and flexibility to address the known declines in muscle strength and quality (14) associated with aging which may have important implications for reducing MSK injuries in this aging workforce.
- While BMI is considered an estimate of adiposity, the high risk for various health diseases associated with elevated BMI combined with the physical demands of firefighting may increase overall disease risk among firefighter; injury prevention strategies need to target all these areas to be effective.

Limitations:

- Although the firefighter injury data provided important insights into firefighter injury burden, it was difficult to determine the extent of injuries sustained and whether the injury reported was the primary injury or the most "severe" injury.

- Firefighters reported more than one injury (1.5 +/- 1.4) however it was unclear whether the injury data was representative of all injuries reported by a single firefighter or whether it represented one injury. Coding injuries in a way that would enable insights into whether the injury represented a single injury or multiple injury would enable analysis of a possible link between multiple injuries and severity with further impact on development of injury prevention strategies.
- Identifying and reporting both injury type (i.e., fracture, injury to muscle, injury to ligament) and the associated body type (i.e., upper extremity, neck, back) corresponding to each injury event would allow a more specific analysis that would enable development of more targeted injury prevention programs.

PERSONAL PROTECTIVE EQUIPMENT MAY INFLUENCE FIREFIGHTER INJURY SEVERITY

Findings:

- The most frequently worn PPE when injuries are reported is the helmet, helmet line, coat, and boots. The least frequently worn is hose key belt, other eye protection and breathing apparatus.
- When stratified by injury severity, the helmet and boots were worn when injuries resulting in less time absence from work (minor injuries) were reported.
- Serious injuries (those requiring longer absences from work) were reported when boots, helmet and the coat of the bunker gear were worn.

Implications and Limitations:

- Previous research has identified that bunker gear (15, 16, 17) including firefighter boots (18), impact the way that firefighting tasks are performed and may increase risk for musculoskeletal injury.
- The current data doesn't allow conclusions regarding causality of injury however, the database suggests that MSK injuries are the most frequent. Improvements in the way this type of data is collected may provide further insights into the link between task performance strategies, PPE and injury.
- There are important limitations with this finding as PPE data are reported as either "yes" (PPE worn) or "unknown". Although the option for "no" (PPE not worn) is also provided there was no data reported in this data; consequently, the reliability of this data remains unclear.
- It is difficult to make conclusive comments regarding the impact of PPE on injury however, results suggest that if firefighters choose to accurately report the type of PPE worn when an injury is experienced, particularly where MSK is the primary injury type amongst firefighters, it may inform strategies to change equipment to reduce exposure to risk factors associated with musculoskeletal injuries.

FIRE RESPONSE CHARACTERISTICS MAY INFLUENCE FIREFIGHTER INJURY SEVERITY

Findings:

- Smaller initial and subsequent crew sizes appear to influence injury severity such that smaller crew sizes may be related to more serious injuries (1.6 ± 2.1); however specific injury characteristics such as types and anatomical location remains unclear.
- Data reporting for method of fire control and extinguishment, as well as the number of engines, were unknown for all incidents (firefighter injuries) in our analytic sample.

Implications and Limitations

- The relationship between crew size and injury severity provided unique initial insights into the relationship between fire ground support and firefighter injury severity suggesting that crew size may influence firefighter injury.
- As firefighter injury parameters (i.e., type and anatomical location) continue to be developed, the relationship between crew size and firefighter injury may be further explored with respect to firefighter injury and specific fire suppression tasks.
- Incorporating information about the method of fire control and extinguishment with crew size relative to specific injury parameters will provide further insights into the relationship between specific fire suppression tasks and firefighter injuries.
- Integrating this information with firefighter personal attributes such as height, weight and gender may also enable unique insights into the ergonomics of performing fire suppression activities.

ALL VICTIM CHARACTERISTICS AND FIREFIGHTER INJURY SEVERITY AND TYPE

Findings

- The highest number of injuries (2.27 ± 3.00) experienced by any victim (i.e., civilian and other emergency response personnel) was associated with firefighters reporting asphyxia or respiratory distress.
- Firefighter absence from work was longer (serious injury) when there were more total injuries (1.64 ± 1.19) related to the fire response tasks.

Implications and Limitations

- Preliminary analysis suggests there may be a relationship between firefighters' respiratory distress and total injuries as well as firefighter absence from work and total injuries.
- Relationships between injuries in firefighters, civilians, bystanders, and other emergency response personnel should be further explored to determine the factors that pose increase risk for injury.
- Our understanding of injury risk would be improved by reports of estimated persons on site during a fire incident. By quantifying the number of non-injured persons associated with an incident, the prevalence of injuries could be calculated as an indicator of risk

GEOGRAPHICAL LOCATION AND FIREFIGHTER INJURY SEVERITY AND TYPE

Findings

- Complete data corresponding to firefighter injury, specifically injury type, firefighter status and personal attributes (i.e., height, weight, years of service) were only available for Ontario which limited our injury data analysis.

Implications and Limitations

- Although the firefighter injury data provided important insights into firefighter injury burden in Canada, a primary limitation is that the "victim" data for professional firefighters was limited our sample to Ontario.
- Our interpretation of injury severity and type across jurisdictions was precluded by the firefighter status reported by Ontario only.
- A geographical perspective of firefighter injuries would be valuable for identifying risk factors for injury, therefore we encourage all jurisdictions to report firefighter status, as well as injury severity and type.

Overall Implications and Next Steps

OVERALL IMPLICATIONS

- Although firefighter injury severity (i.e., length of absence resulting from injury) is declining as well as the reported number of musculoskeletal injuries, there continues to be a substantial burden of injury related to MSK.
- Our results support previous findings that firefighting is an aging workforce, which is thematic of many occupational groups across Canada.
- There may be a difference in the type and severity of injury across different age-groups, but this requires further controlled analysis that wasn't available with the current database.
- Fire response characteristics including crew-size (initial and subsequent) as well as fire alarm operation may impact firefighter injury including increasing length of absence from work.
- Firefighter injuries may increase as the total number of injuries at the fire scene increase.
- The data collected by the NFID is valuable and has provided important insights into the relationship between firefighter injury and fire suppression tasks.

NEXT STEPS

- Current findings supported by previous research supports the recommendation for injury prevention programs that target musculoskeletal health including muscle strength and endurance and flexibility. The long-term impact of these programs on MSK injury prevention needs to be evaluated in consideration of both the type of injury and resulting length of absence from work (severity).
- We plan to contextualize this new information with our firefighter research partners to verify and incorporate with local data. This information will be invaluable as we develop, implement and evaluate our current evidence-based injury prevention strategies.

Recommendations

- Design, implementation and injury monitoring of MSK injury prevention programs should consider an age-stratified approach. Although female firefighters were minimally represented in this current database (3%) sex/gender specific approaches should be incorporated. Research into the specific hazards and intervention targets for firefighters that can be shown to reduce MSK are warranted.
- A control database that enables comparative analysis between injured and non-injured firefighters would enable linkage between injury variables and fire response characteristics. For example, when reporting data with respect to each fire response activity, fire services could also provide data on the firefighters who participated in the call and did not report an injury. At a minimum, availability of the age/gender distributions of their fire services would enable injury rates to be standardized to the workforce distribution. The role of each team member in the fire response activity may also improve analysis and reporting to enable consideration of the physical demands and associated MSK risks.
- Anonymous reporting of safety equipment usage may provide more valid information about PPE usage that will facilitate understanding of the relationship between firefighter PPE and injury.
- A coding system manual and training resources could improve the quality of the NFID and strengthen conclusions from future analyses.
- Reporting firefighter injury type (i.e., fracture, dislocation, sprain, strain) with specific body location (i.e., lower limb, upper arm, shoulder) would improve the sensitivity of analysis regarding firefighter injuries.
- The NFID and subsequent analyses of firefighter injuries provides important preliminary data that can be taken to local sites for verification and further contextualization that might be used to inform development of firefighter injury prevention programs.
- A national effort for firefighters to link exposure and injury data to health service data would allow for improved tracking of the long-term health consequences; this initiative may require a provincial strategy.

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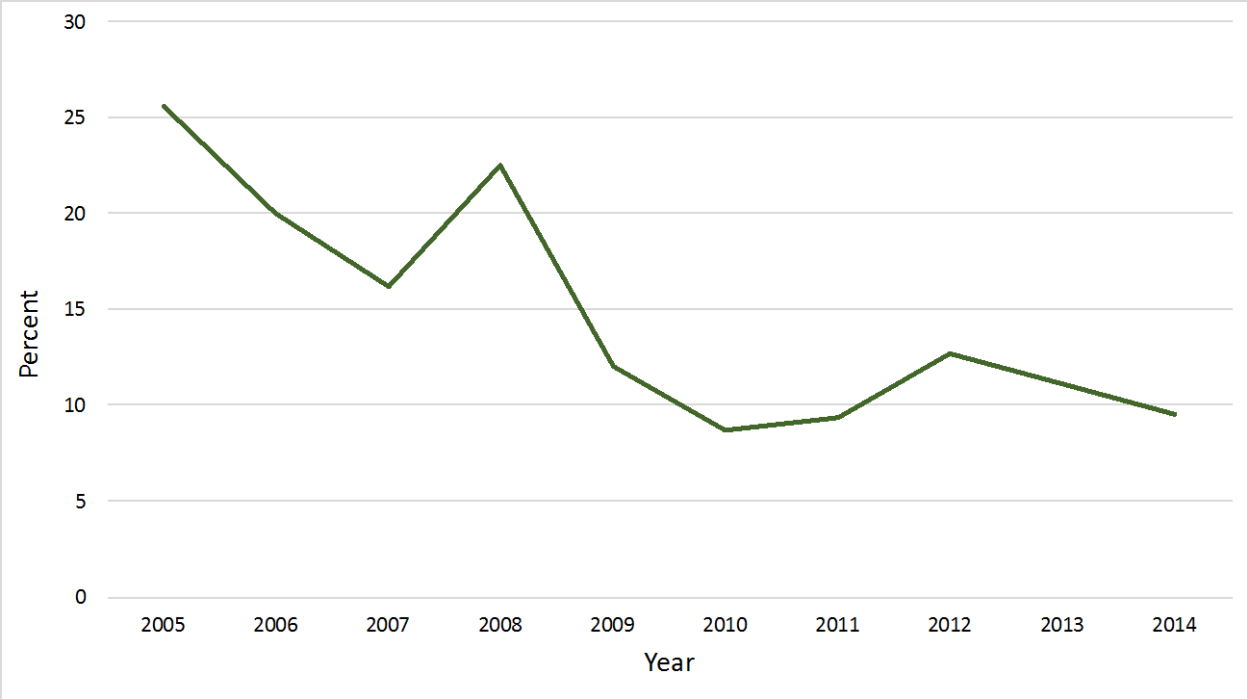
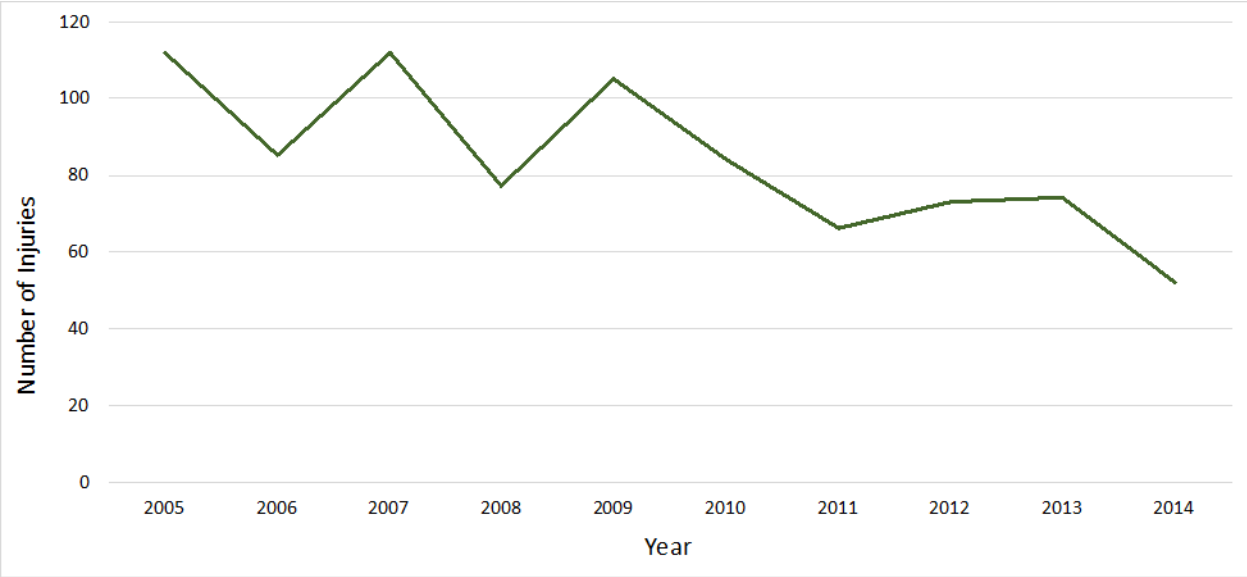
List of Tables and Figures

Appendices

APPENDIX A: ANNUAL PROPORTION OF SERIOUS INJURIES (REQUIRING 16+ DAYS OFF WORK OR IN HOSPITAL) IN FULL-TIME FIREFIGHTERS, ONTARIO, 2005 TO 2014



APPENDIX B: ANNUAL NUMBER OF FIREFIGHTER MUSCULOSKELETAL (BONE, MUSCLE AND JOINT) INJURIES REPORTED BY FULL-TIME FIREFIGHTERS, ONTARIO, 2005-2014



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