Determinants of Injury and Death in Canadian Firefighters

A Case for a National Firefighter Wellness Surveillance System

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Executive Summary

Occupational injury is a significant concern facing the Canadian workforce resulting in lost work time and income, medical expenses, compensation costs, and long-term health problems or disability. Previous research has shown health risks associated with employment as a firefighter, and exposure to a variety of injury-related hazards in the course of their occupation. Extreme temperatures, toxic substances, strenuous physical labour, violence and other traumatic events are potential risks that firefighters may experience when responding to emergency situations.

The purpose of this report is to describe injury, disease and death among Canadian firefighters. The report aims to help the reader to understand the causes of injury, disease and death among Canadian firefighters through an extensive review of previous research, as well as a detailed analysis of injury claims data. Claims data from the Association of Workers' Compensation Boards of Canada (AWCBC) and WorkSafeBC for the years 2006 to 2015 for professional and volunteer firefighters are presented to define priority issues for targeted health promotion and injury prevention interventions.

Main Findings

AWCBC data revealed five principle causes of injury and death among Canadian firefighters: cancer, traumatic injury, cardiovascular disease, respiratory disease and mental health problems. Cancer represented over 86% of all fatal claims, while traumatic injuries accounted for 90% of all time-loss claims among firefighters, affecting an average one in every 50 firefighters each year. Mental health was the third leading cause of time-loss claims among Canadian firefighters, but was considerably less common, affecting an average 1 in 5,000 firefighters per year. While cardiovascular disease was identified in previous research as a leading cause of mortality among firefighters in Canada, this study found that cardiovascular disease fatality claims accounted for only 5% of fatal claims, affecting an average 1 in 35,000 firefighters per year. Finally, respiratory disease accounted for slightly less than 2% of all fatal claims.

While previous research has shown that a *healthy worker effect* may exist among firefighters, AWCBC data provides evidence for increased mortality from cancer among firefighters in comparison to the general population, suggesting that lifestyle factors of firefighters do not play a preventative role in relation to cancer mortality. Separate from these lifestyle factors, firefighters are known to be at a high risk for stressful work situations that can lead to an increased risk for traumatic injury and mental health issues. More recent research suggests that time off work due to mental health concerns is an emerging trend in accepted time-loss claims by firefighters**.**

Conclusion

The findings within this report build on previous research and present further evidence for the risks related to the occupation of firefighting. The results of this study suggest that cancer, traumatic injury and mental health should be priority issues for researchers, employers and policy-makers working to improve firefighter health and safety. Future studies that continue to explore the relationship between the profession of firefighting and injury will improve the understanding of injury risks in

the fire service by employment status. Priority areas include the relationship between traumatic injury and firefighter training and employment status, the onset of a mental health diagnosis in relation to trauma on the job as a firefighter, and site-specific cancer rates among firefighters to inform preventative screening policy.

Recommendations

It is difficult to get a complete and accurate picture of occupational injuries in Canada due to limitations in the available surveillance systems. Currently, there is no provincial or federal database that collects information related to all injuries or deaths that occur in the workplace. The results of this report also provide further evidence of the need for a dedicated firefighter health surveillance model – one that can monitor health trends and patterns among firefighters and which permits earlier preventative interventions. Given the inherent limitations of using occupational claims data to analyze injury and death within an occupation, a national firefighter injury surveillance model is needed to support future research, as well as timely and responsive intervention.

This report presents valuable evidence supporting the concept that firefighters are at an increased risk for certain causes of injury, disease and death. Dedicated resources should be devoted to health promotion and injury prevention among firefighters across Canada. Primary prevention and earlier detection, such as site-specific cancer screening, is essential to decrease the burden of cancer among the firefighter population. It is recommended that fire departments implement health and wellness programs as a key component of employee programs that focus on the primary prevention of cancer and traumatic injury, and the promotion of mental health.

Introduction

In 2015, 852 workplace deaths were recorded in Canada. In this single year, there were 232,629 accepted claims for lost time due to a work-related injury or disease. [1] The consequences of occupational injuries can be immense, including lost work time and income, medical expenses, compensation costs, and long-term health problems or disability. In addition, an occupational injury can place a burden on the family, friends, and employer of the injured worker.

Occupational health and safety hazards can transpire in any economic sector. Globally, 30-50% of workers report exposure to physical, chemical or biological situations at work that may be hazardous to their health. [2] In 2010, the average worker spent almost 8 hours at work each work day. [3] According to the OECD Better Life Index, Canadians spend an estimated 20% of their lives at work each year. [4] With a large portion of an individual's life dedicated to time in the workforce, it is important to understand the risks associated with a chosen career.

Many factors can contribute to an occupational injury or disease. A theoretical model of occupational injury shows that the risk for injury in the work force arises from the relationship between the work environment or job tasks, the organization of the work, and the behavioural characteristics of the individual. Safety performance behaviours have been found to be directly related to safety knowledge and safety motivation. [5]

In Canada, firefighters are employed by a municipality in a professional or volunteer capacity, depending on the size of the community. The roles and responsibilities of professional firefighters include a wide variety of tasks. The main duties can include responding to emergency situations such as fires, motor vehicle crashes, building collapses and forces of nature; rescuing victims, and providing first aid and medical assistance; controlling fires using equipment; training; and providing safety education to the public. [6]

Employment as a firefighter has been shown to pose a health risk to the employee. Some hazards known to be associated with the role of a firefighter include exposure to contagious and infectious diseases, and exposure to toxic products. In addition, the physical demands from strenuous physical labour, repetitive movements, prolonged postures and activities for extended periods under extreme conditions can result in overexertion, muscular strains, and other ergonomic concerns. Exposure to extreme temperatures, excessive noise or involvement in dangerous situations from fire, unstable structures, falling objects or extreme heights can all cause physical illness or injury. Further, exposure to dangerous situations or traumatic events, as well as the impact of shift work, can result in long-term psychological concerns. [7]

Due to the potential risks to firefighters in the workplace, there are many protective policies and guidelines incorporated into the job by the employer. This report aims to describe the causes of injury, disease and death among Canadian firefighters through an extensive review of relevant literature, together with analysis of the Association of Workers' Compensation Boards of Canada and WorkSafeBC injury and fatality time-loss claims data.

Methodology

Literature Review

An extensive search of relevant literature was conducted using the following electronic databases: Medline, Embase, Web of Science and SafetyLit. The search strategy included articles for the years 2000 to 2017 that identified causes of injury and death among firefighters. Approximately 300 articles were identified and subsequently reviewed. Of these, 119 articles met the inclusion criteria and were included in the final review. Inclusion criteria were defined as follows: a study population of firefighters from a developed country, and peer-reviewed articles published, or available for translation, in English. Articles that focused on the health impacts of natural disasters or single occurrence traumatic events were excluded, as they were not representative of the entire Canadian firefighter population.

Two independent reviewers subjected the final 119 articles to quality assessment using the Downs and Black checklist. [8] After quality review, a total of 62 articles were selected as high-quality studies and were included in the final analysis and results presentation.

Data Analysis

Analysis was performed on data from two sources. The Association of Workers' Compensation Boards of Canada (AWCBC) provided national data on accepted time-loss claims due to injury and fatality claims. In addition, provincial time-loss and fatality claims data for British Columbia were provided by WorkSafeBC. It is important to note that these data do not include all workplace injuries; only accepted claims for time-loss injuries and fatalities are presented in this analysis.

The AWCBC publishes accepted time-loss injury and fatality reports under the National Work Injuries Statistics Program (NWISP). Data are submitted to the AWCBC by the twelve provincial and territorial Canadian Workers' Compensation Boards and Commissions (WCB), with the Northwest Territories and Nunavut combined. Each provincial and territorial WCB organization codes their own data. As such, coding practices may vary among provinces and territories. The AWCBC defines a time-loss injury as, *an injury for which a worker is compensated for a loss of wages following a work-related incident (or exposure to a noxious chemical) or receives compensation for a permanent disability with or without time lost in his or her employment*.

The AWCBC data includes firefighter time-loss and fatality claims for the years 2006 to 2015, inclusive. Time-loss claims data were provided for all provinces and territories, whereas fatality claims data were provided for all provinces and territories except Nunavut, Northwest Territories, Newfoundland and Prince Edward Island. The AWCBC data were provided in a series of five tables describing nature of injury, body part injured, cause of injury, event, and occupation status by age group, gender, year of claim, and province for fatalities and time-loss claims. In the AWCBC data, small numbers are suppressed to protect the privacy of individual claimants. Any count equal to or less than 3 was replaced in the data set with an "X" to protect personal identification. For the purposes of this analysis, each "X" value was randomly replaced with the value 1, 2 or 3. This random allocation of values to suppressed numbers ensured our ability to conduct the analysis without the concern of dealing with missing data. Data were then analyzed to provide descriptive and cross-tabulated statistics related to firefighter time-loss and fatality claims.

When interpreting the AWCBC data, coding for the variable Nature of Injury (including disease) was grouped as shown in Appendix A, Table 3. To calculate the average annual rate of time-loss and fatality claims, two methodologies were considered: a) use the true total values provided within the AWCBC dataset as the indicator value for total number of claims; or b) use aggregated values across provinces, including randomly allocated values to suppressed numbers to calculate the total number of claims. Both methods yielded comparable results, as seen in Appendix 2, Table 1. To ensure analogous methodology throughout the paper, method B was utilized to calculate rates throughout the paper. To calculate the average annual number of claims by province, total fatality and total time-loss claims were each divided by the number of years reported. Appendix A, Table 2 provides an overview of the years reported for each province on time-loss and fatality claims.

In order to compare the number of time-loss and fatality claims by province, in comparison to the number of firefighters employed in each province, firefighter population estimates were received from the Canadian Association of Fire Chiefs. Firefighter population estimates by province/territory were used to calculate the average annual rate of time-loss and fatality claims per 100,000 firefighter population. Firefighter population estimates are based on 2012 data and are displayed in Table 1.

TABLE 1: NUMBER OF FIRE DEPARTMENTS, PROFESSIONAL FULL-TIME FIREFIGHTERS AND VOLUNTEER FIREFIGHTERS IN CANADA, BY PROVINCE/TERRITORY, 2012, CANADIAN ASSOCIATION OF FIRE CHIEFS

	AB	BC	MB	NB	NL	NWT	NS	NU	ON	PEI	QU	SK	YU
Fire Departments	435	460	215	170	301	33	314	25	462	36	723	508	26
Full Time Firefighters	3500	3800	977	600	315	31.5	425	17	11032	10	4288	650	40
Volunteer Firefighters	6500	8100	3364	4000	5900	402	7500	346	19263	1000	17310	6400	305

WorkSafe BC claims data was analyzed to provide further information on employment status of firefighters in relation to cause of injury and death. Accepted claims data was provided for the years 2006 to 2015, inclusive and included information on fatality and volunteer status. Information was also provided for the variables body part injured, gender and age group. When interpreting the WorkSafe BC data, coding for the variable Nature of Injury (including disease) was grouped as shown in Appendix A, Table 4.

Risk Assessment: Determinants of Injury and Death

Literature Review

Career firefighters have the second highest injury rates among emergency responders. [9] A 2015 Australian study discovered that from 2003 to 2012, there were 6,997 reported firefighter injuries on the job, accounting for 177 injuries per annum per 1,000 full-time employees. [10] A 2016 study involving 19,000 Korean firefighters found that 354 firefighters per 1,000 workers experienced one or more injuries in the previous year. The odds ratio (OR) of injury was 1.86 for firefighters (95% CI= 1.61-2.15) in comparison to officers[1] when adjusting for age, marital status, smoking habit and career period. These injuries accounted for an age-standardized absence days from work of 1,120 days per 1,000 workers in the previous year. [11]

In a 2013 American study of 462 male career firefighters in the Missouri Valley Region, 20.1% of firefighters reported having one injury, 3.0% reported having two injuries and 1.7% reported having three or more injuries within the previous 12-months. The primary types of injuries reported were dislocation, strain or sprain (76.3%) and superficial or open wound injuries (13.0%). [12] In a 2015 study of 3,289 full-time paid firefighters in Greece, 11% of respondents reported a work-related injury, with the most common types of injury reported being strains, acute back pain and ankle injuries. In addition, 13% of respondents met the diagnostic criteria for Post-Traumatic Stress Disorder (PTSD) symptoms. [13]

The most common cause of injury in a recent Australian study was muscular stress (74 injuries per 1,000 full-time employees annually), including sprains and strains. The most common body parts injured were the knee, lower back, shoulder and ankle. [10] Suyama studied 850 firefighters over the course of 29-months, with 477 worker's compensation reports were recorded during this time period; 73.8% were from minor trauma, 11.7% were from blood-borne pathogen exposures, 5.7% were from inhalation exposures, 8.8% were from cardiovascular disease, motor vehicle trauma, heat or burns. [14]

In 2015, a Korean study found that all-cause mortality (adjusted relative risk (ARR) = 1.46, 95% CI=1.13-1.89), overall cancer mortality (ARR = 1.54, 95% CI = 1.02-2.31) and mortality from external injury, poisoning and external causes (ARR = 3.13, 95% CI = 1.80-5.46) were significantly higher among firefighters employed for more than 20-years in comparison to non-firefighters and to firefighters employed less than 10-years. [15]

Many articles within this review indicate that firefighters have an increased risk for traumatic injury. Compared with office workers, a 2004 study found that firefighters reported less exposure to sitting and an increase in biomechanically demanding activities, increased knee and ankle complaints and disabilities resulting from back complaints, and reduced hypertension, stomach, heart, neck, shoulder and arm complaints. [16] Hong determined that approximately 66% of firefighters experienced occupational injuries and 56% reported multiple injuries. Firefighters with more than 17-years in fire services were more likely to report injuries (OR= 2.96; 95% CI = 1.92-4.58) and

[1] Officers were considered individuals who perform administrative work, investigate fire grounds, or are involved in communication and informational systems.

multiple injuries (OR = 2.47; 95% CI = 1.49-4.10). The most commonly reported injuries were muscle strains and sprains (74%), extremity injuries (60%), back injuries (54%), and burns (28%). [17] Britton found that the most common injury mechanism was slips, trips and falls followed by use of equipment, tools and machinery. [18] In addition, Vaulerin determined that sprains were the most common type of injury, followed by tendinitis and muscle tears, and Baarts reported that firefighter's highest associated injury category was upper extremity injuries. [19,20]

When comparing male firefighters to the general population, Baris found that there were statistically significant excess risks for ischemic heart disease (SMR=1.09). [21] This study determined that there is a decreased risk for mortality from nervous system diseases (SMR=0.47), cerebrovascular diseases (SMR = 0.83), respiratory diseases (SMR = 0.67), genitourinary diseases (SMR = 0.54), all accidents (SMR = 0.72), and suicide (SMR = 0.66). Mecham found that 1,100 emergency service injury reports were submitted during the study period, of which 44 (4.0%, 95% CI 0-10.9%) involved an assault, and 9 of these incidents were assaults on firefighters. [22]

Data from the United States Fire Administration (USFA) fatality database revealed that between 1990 and 2000, myocardial infarction was shown to have increased from 43% to 46.5% of firefighter deaths, cerebrovascular accident increased from 1.7% to 3.6% of deaths, asphyxiation decreased from 12.1% to 7.9% and burns decreased from 7.7% to 3.9%. The percentage of fatalities of firefighters over age 40 has increased from 52% to 65%. [23] In a 2005 study, 1,411 male and 38 female firefighter deaths with known causes were identified. In male firefighters there was no excess overall mortality from cancer, however female firefighters had an increased risk for atherosclerotic heart disease (SMR = 3.85; 95% CI: 1.66-7.58). [24]

Hodous looked at the USFA annual summary of firefighter line-of-duty deaths and National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) reports. [25] Firefighter deaths between 1998 and 2001 were analyzed and categorized. Of a total 410 firefighter deaths, 47% were medical deaths, of which 90% were due to myocardial infarction. The majority of these fatalities occurred at, or just after, a fire scene, indicative of the physical and psychological stresses of the firefighting profession. Motor vehicle fatalities comprised 18% and non-motor vehicle trauma comprised 35% of all firefighter deaths. Among non-motor vehicle traumatic fatalities, 48% were from burns or asphyxiation. [25]

Contrary to these findings, Amadeo found that firefighters had lower all-cause mortality than the general population (standardized mortality ratio (SMR)=0.81; 95%CI: 0.77-0.85). [26] While finding no significant excess of mortality for any specific cause, this 2015 study did find that a greater number of deaths than expected occurred for various digestive neoplasms. In addition, a 2001 study by Baris found that firefighters had a similar mortality rate to the general United States male population for all cancers (SMR=1.10) and all causes of death combined (SMR=0.96). [21] Wagner determined that the conditional life expectancy of a German firefighter is 2.4 years longer than the normal male German population. [27]

Data Analysis

Based on the AWCBC data, the leading causes of fatality claims by firefighters in Canada between 2006 and 2015 were cancer (86.1%), traumatic injuries (6.5%), cardiovascular system diseases (4.9%) and respiratory system diseases (1.8%) (Table 2). The leading causes of time-loss claims by firefighters in Canada between 2006 and 2015 were traumatic injuries (89.9%), musculoskeletal system and connective tissue diseases (2.3%), and mental health (1.7%) (Table 3). Among all time-loss claims, 95.1% were made from firefighters who self-identify as male, whereas all fatality claims resulted from deaths among male firefighters.

TABLE 2: FATALITY CLAIMS BY NATURE OF INJURY, 2006-2015, CANADA, AWCBC[i]

Nature of Injury	Fatalities-% of claims*	Fatalities - Rate per 100,000 FF*
Cancer	86.1%	50.0
Traumatic Injury	6.5%	4.4
Cardiovascular system diseases	4.9%	2.9
Respiratory system diseases	1.8%	1.4
Nervous system diseases	0.9%	0.2
Unknown	0.5%	0.6
Infectious, bacterial, viral, parasitic diseases	0.4%	0.1
Mental health	0.4%	0.2
Digestive system diseases	0.0%	0.0
Genitourinary system diseases	0.0%	0.0
Musculoskeletal system and connective tissue disease	0.0%	0.0
Skin and subcutaneous tissue disorders	0.0%	0.0
Other	0.0%	0.0

**includes AB, BC, MB, NB, NS, ON, QC, SK, YU only*

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

TABLE 3: TIME-LOSS CLAIMS BY NATURE OF INJURY, 2006-2015, CANADA, AWCBC[i]

Nature of Injury	Time-loss- %	Time-loss claims - Rate per 100,000 FF
Traumatic Injuries	89.9%	1661.3
Musculoskeletal system and connective tissue diseases	2.3%	33.7
Mental health	1.7%	24.0
Cancer	1.5%	23.5
Digestive system diseases	1.0%	15.1
Nervous system and sense organs diseases	0.9%	13.1
Other	0.8%	12.4
Unknown	0.6%	8.9
Cardiovascular system diseases	0.5%	6.5
Infectious, bacterial, viral, parasitic diseases	0.3%	5.3
Skin and subcutaneous tissue diseases	0.3%	4.6
Respiratory system diseases	0.2%	3.0
Genitourinary system diseases	0.0%	0.6

1. [i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

Leading Causes of Injury and Death

Based on the literature review and analysis of available data, five principal and emerging trends have been identified regarding injury and death among firefighters. According to the AWCBC data, cancer, traumatic injury, cardiovascular disease, and respiratory disease are the leading causes of fatality claims among Canadian firefighters. The literature supports these four causes as sources of mortality among firefighters across the world. In addition, AWCBC data revealed that many time-loss claims by firefighters are due to mental health reasons, also an emerging trend in the literature as a significant contributor to lost time at work. For this reason, the five sub causes of cancer, traumatic injury, cardiovascular disease, respiratory disease, and mental health are further analyzed below.

Cancer

Occupational cancer can arise when an employee is exposed to whole or partial particles of a carcinogen in the workplace. [28] The proportion of cancer that can be attributed to occupational exposure varies with type of cancer and occupation. Across all professions, the most common forms of occupational cancer are lung cancer, bladder cancer and mesothelioma. [29] The World Health Organization International Agency for Research on Cancer Monograph Working Group concluded in 2007 that firefighters face adverse occupational exposures in their employment, including exposure to human carcinogens resulting in increased relative risks for testicular and prostate malignant neoplasms and non-Hodgkin's lymphoma. [30]

While firefighters are subject to the same basic genetic and environmental factors that predispose for cancer as the standard public, in the course of their duties they are confronted with additional risks and exposures that place them in even greater peril of acquiring and subsequently dying of

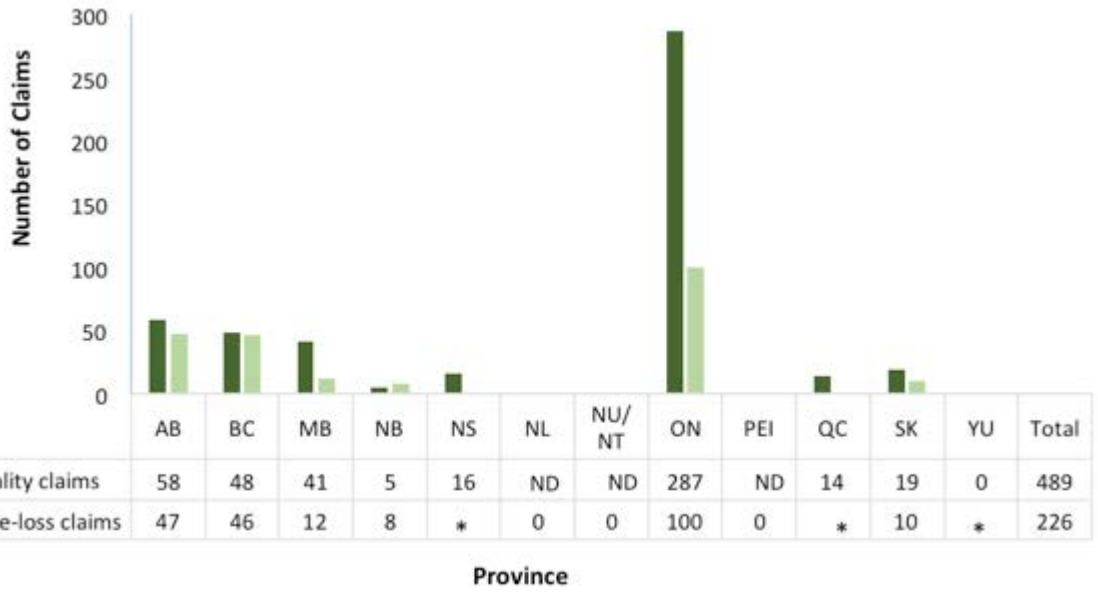
cancer. While engaged in fire suppression and overhaul activities, often in uncontrolled and hazardous environments and over the span of many years, firefighters are repeatedly exposed to complex mixtures of concentrated carcinogens, which are generated de novo in the intense heat and pressure of a fire. When organic and inorganic materials, such as those found in furniture, chemicals, plastics, metal alloys, and modem construction materials are subject to incomplete thermochemical decomposition, potentially thousands of toxic combustions products are produced and aerosolized into the smoke, soot, and tar generated by the fire. Benzene, polycyclic aromatic hydrocarbons, dioxins, polychlorinated biphenyls, asbestos fibers, and heavy metals such as lead, arsenic, and cadmium are only a few examples of the carcinogens released. Furthermore, even the most efficient personal protective equipment offers insufficient protection against these toxins, as many firefighters anecdotally report smelling like smoke or burning plastic for days after fighting a fire. The carcinogens thus encountered can be inhaled through the lungs, inadvertently swallowed via the upper aerodigestive tract, or absorbed in significant concentrations directly through the skin, when firefighters remove and handle contaminated bunker gear and equipment. In addition to the risk factors outlined above, the International Agency for Research on Cancer (2010) has classified the shift work that firefighters often operate under as a group 2A carcinogen, probably by reason of disruption of the circadian clock genes involved in the sleep-wake cycle. [28]

Cancer was responsible for 86.1% of all fatality claims by firefighters in Canada between 2006 and 2015[2], at an annual rate of 75.7 fatalities per 100,000 Canadian firefighter population[3]. During this period 1.5% of time-loss claims by Canadian firefighters were due to cancer, with an annual rate of 30.3 per 100,000 firefighter population.

Nationally, Ontario accounted for 44% of all time-loss claims and 50% of all fatality claims related to cancer among firefighters (Figure 1). Ontario and Manitoba experienced the highest average rates of cancer fatalities per firefighter population in an average year, at 94.7 and 94.5 per 100,000 firefighter population, respectively. The highest rates of time-loss claims among firefighters were in the Yukon (96.6 per 100,000 firefighter population), Alberta (58.0 per 100,000 firefighter population) and British Columbia (51.3 per 100,000 firefighter population) (Figure 2). The majority of fatality claims due to cancer were submitted by male firefighters over the age of 65 years. However, over 30% of all time-loss claims due to cancer were for male firefighters between the ages of 45-59 years (Figure 3).

[2] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only
[3] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only

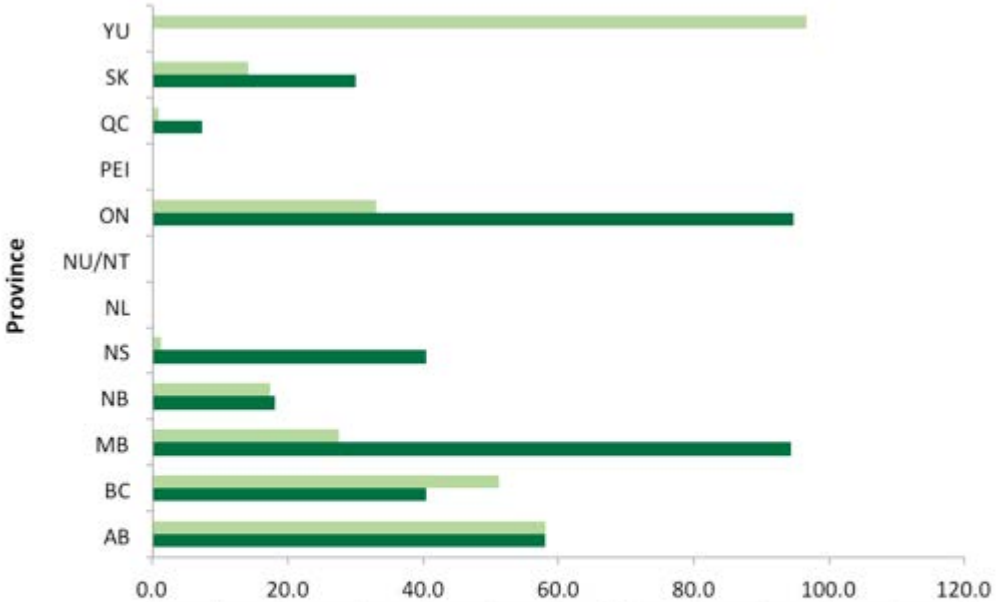
FIGURE 1: FIREFIGHTER CANCER TIME-LOSS AND FATALITY CLAIMS, BY PROVINCE, 2006-2015, AWCBC[i]



	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU	Total
Fatality claims	58	48	41	5	16	ND	ND	287	ND	14	19	0	489
Time-loss claims	47	46	12	8	*	0	0	100	0	*	10	*	226

ND *no data provided*
*Indicates a value of 1≤ X ≤ 3
[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 2: CANCER TIME-LOSS AND FATALITY CLAIMS AVERAGE ANNUAL RATES PER 100,000 FIREFIGHTER POPULATION BY PROVINCE, 2006-2015, AWCBC[i]



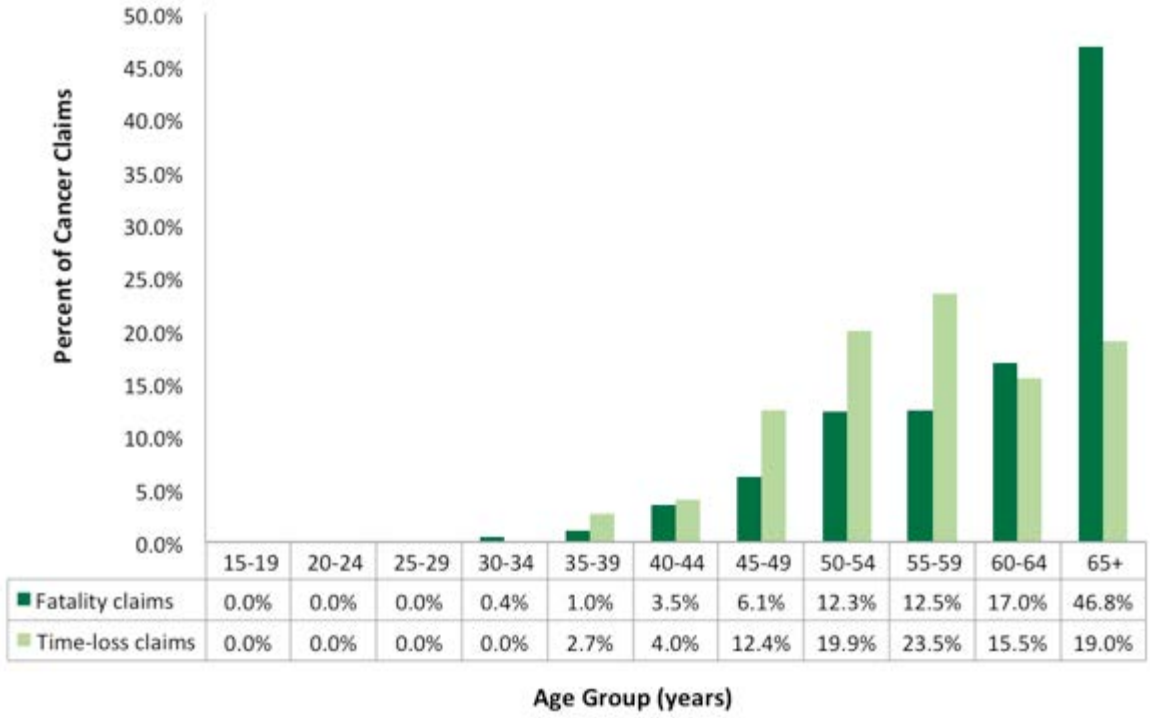
	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU
Time-loss claims	58.0	51.3	27.6	17.4	1.3	0.0	0.0	33.0	0.0	0.9	14.2	96.6
Fatality claims	58.0	40.3	94.4	18.1	40.4	ND	ND	94.7	ND	7.2	29.9	0.0

Rate per 100,000 Firefighter Population

ND= No data provided

[i]Note: random allocation of suppressed small numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 3: PERCENT OF ALL CANCER CLAIMS, BY AGE GROUP, 2006—2015, CANADA, AWCBC



	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
Fatality claims	0.0%	0.0%	0.0%	0.4%	1.0%	3.5%	6.1%	12.3%	12.5%	17.0%	46.8%
Time-loss claims	0.0%	0.0%	0.0%	0.0%	2.7%	4.0%	12.4%	19.9%	23.5%	15.5%	19.0%

Korean firefighters have experienced excess morbidity in several cancer types, including colorectal and urologic cancers, and non-Hodgkin's lymphoma, demonstrating similar trends to previous studies for firefighters conducted in other countries. [15] However, a 2016 study found that paid Australian firefighters have reduced mortality from cancer in comparison to the general population. [31]

Amadeo found no significant increase in mortality among firefighters for any specific cause, however the study found a greater number of deaths occurring for cancers of the rectum/anus, pancreas, buccal-pharynx, stomach, liver, and larynx. [26] As well, Baris found the risks of mortality from colon cancer (SMR=1.68), kidney cancer (SMR=2.20), non-Hodgkin's lymphoma (SMR=1.72), multiple myeloma (SMR=2.31), and benign neoplasms (SMR=2.54) were increased among firefighters with at least 20 years of service. [21] While this study found no significant increase in overall mortality among Philadelphia firefighters, increased mortality for cancers of the colon and kidney, non-Hodgkin's lymphoma and multiple myeloma were observed.

From a pool of 19,309 eligible male firefighters, a 2015 study identified 1,333 cancer deaths and 2,609 cancer incidence cases. [32] Significant positive associations occurred between fire-hours and lung cancer mortality and incidence, and between fires attended to and leukemia mortality. Lung cancer and leukemia mortality risks increased moderately with increases in firefighter exposure. A 2016 study observed no increased risk of lung cancer in firefighters, even after adjustment for smoking and exposure to other occupational lung carcinogens. [33]

In comparison, a study of 36,813 firefighters followed between 1972 and 1999 found no excess overall mortality from cancer among male firefighters compared to the general population, but excesses mortality rates did exist for male breast cancer (SMR=7.41; 95% CI: 1.99-18.96) and thyroid cancer (SMR=4.82; 95% CI: 1.30-12.34)]. Mortality from bladder cancer was also increased (SMR=1.79; 95% CI: 0.98-3.00). Female firefighters had similar morality patterns to Florida women, except for increased standard mortality rates for atherosclerotic heart disease (SMR=3.85; 95% CI: 1.66-7.58). [24]

In a cohort of 2,200 Scottish firefighters followed between 1984 and 2005, the overall mean annual cancer incidence rate was 86.5 per 100,000 population versus 123.7 per 100,000 general population; and the overall mean annual cancer mortality rate was 20.4 per 100,000 population, in comparison to 59.9 per 100,000 general population. For specific cancers, the incidence of melanoma was found to occur at a rate of 13.6 per 100,000 population, kidney cancer incidence rate was 9.1 per 100,000 population and kidney cancer mortality rate was 6.5 per 100,000 population. Large bowel cancer incidence rate was 9.1 per 100,000 population and lung cancer incidence rate was 6.8 per 100,000 population. These cancer rates were found to be lower than those of the general Scottish population. [34]

Glass proposed that lower mortality rates from cancer were likely a result of a strong, healthy worker effect and lower smoking rates among firefighters compared with the general Australian population. [31] Daniels found significant negative associations were evident for the exposure surrogates and colorectal and prostate cancers, suggesting a healthy worker survivor effect, possibly enhanced by medical screening. [32]

A summary of the global literature pertaining to the risk of cancer incidence and mortality among firefighters is presented in Table 4.

TABLE 4: SELECTED ARTICLES- CAUSES OF INJURY AND DEATH AMONG FIREFIGHTERS: CANCER

Author (Year)	Title	Objective	Cancer Rates
Ahn YS (2012) [35]	Cancer morbidity of professional emergency responders in Korea.	To estimate cancer morbidity in Korean male professional emergency responders and compare that with the Korean male general population.	Colorectal cancer: SIR=1.27, 95% CI= 1.01-1.59 Kidney cancer: SIR= 1.56, 95% CI=1.01-2.41 Bladder cancer: SIR=1.60, 95% CI=1.01-2.56 Non-Hodgkin's Lymphoma: SR=1.69, 95% CI= 1.01-2.67)
Bates MN (2007) [36][4]	Registry-based case-control study of cancer in California firefighters.	To determine if California (U.S.) professional firefighters were at an increased cancer risk relative to other occupations.	Testicular cancer: OR= 1.54, 95% CI= 1.18-2.02 Melanoma: OR= 1.50, 95% CI=1.33-1.70 Brain cancer: OR=1.35, 95% CI=1.06-1.72 Esophageal cancer: CI= 1.48, 95% CI= 1.14-1.91 Prostate cancer: OR=1.22, 95% CI= 1.12-1.33

[4] All results are displayed in Appendix B, Figure 3

Author (Year)	Title	Objective	Cancer Rates
Bigert C (2016) [33]	Lung cancer risk among firefighters when accounting for tobacco.	To investigate the risk of lung cancer among European, Canadian, New Zealand and Chinese firefighters, while controlling for smoking habits.	Lung cancer: OR=1.03, 95% CI= 0.77-1.38 Lung cancer (adj. for smoking): OR= 0.68-1.32
Daniels RD (2014) [37][5]	Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950-2009).	To examine mortality patterns and cancer incidence in a pooled cohort of 29,993 San Francisco (U.S.) career firefighters employed since 1950 and followed through 2009.	Overall cancer mortality: SMR=1.14, 95% CI= 1.10-1.18 Overall cancer incidence: SIR= 1.09, 95% 1.06-1.12 Lung cancer: SMR=1.10, 95% CI= 1.04-1.17 / SIR=1.12, 95% CI= 1.04-1.21 Intestine cancer: SMR=1.30, 95% CI= 1.16-1.78 Rectum cancer: SMR= 1.45, 95% CI= 1.16-1.78 Kidney cancer: SMR= 1.29, 95% CI= 1.05 to 1.58 / SIR= 1.27, 95% CI= 1.09-1.48 Mesothelioma: SMR= 2.00, 95% CI= 1.03-3.49 / SIR= 2.29, 95% CI= 1.60-3.19
Pukkala E (2014) [40][6]	Cancer incidence among firefighters: 45 years of follow-up in five Nordic countries.	To examine the patterns of cancer among Nordic firefighters, and to compare them with the results from previous studies.	All cancer sites combined: SIR=1.06, 95% CI= 1.02 - 1.11) Multiple myeloma (70+ years): SIR=1.69, 95% CI= 1.08 - 2.51 Adenocarcinoma of the lung (70+ years): SIR=1.90, 95% CI= 1.34 - 2.62 Mesothelioma (70+ years): SIR=2.59, 95% CI= 1.24 - 4.77 Testicular cancer: SIR=0.51, 95% CI= 0.23 - 0.98 Prostate cancer: (SIR=1.13, 95% CI 1.05 to 1.22) Skin melanoma: (SIR=1.25, 95% CI 1.03 to 1.51) Non-melanoma skin cancer: (SIR=1.33, 95% CI 1.10 to 1.59)
Paget-Bailly S (2013) [39]	Occupation and head and neck cancer risk in men: Results from the ICARE Study, a French population-based case-control study.	To investigate the associations between occupations and head and neck (HN) cancer risk in French men.	Oral cavity cancer: OR= 10.2, 95% CI= 3.1-34.0 Oropharynx cancer: OR= 1.9, 95% CI= 0.4-09.9 Oral cavity/pharynx cancer unspecified: OR= 11.3, 95% CI= 2.0-63.9 Hypopharynx: OR= 3.1, 95% CI=0.6-17.1 Larynx: OR= 1.2, 95% CI= 0.1-9.9

[5] All results are displayed in Appendix B, Figure 4
[6] Full results in Appendix B, Figure 6

Author (Year)	Title	Objective	Cancer Rates
Glass DC (2016) [31][7]	Mortality and cancer incidence in a cohort of male paid Australian firefighters.	To investigate mortality and cancer incidence of paid male Australian firefighters and of subgroups of firefighters.	Overall risk of cancer: SIR= 1.09, 95% CI= 1.03-1.14 Overall cancer mortality: SMR= 0.81, 95% 0.72-0.90 Prostate cancer: SIR= 1.23, 95% CI= 1.10-1.37 Melanoma: SIR= 1.45, 95% CI= 1.26-1.66
Tsai RJ (2015) [41]	Risk of cancer among firefighters in California, 1988-2007.	To determine cancer risks among Californian (U.S.) firefighters that reflect risks from advances in building materials.	Melanoma: OR=1.8, 95% CI= 1.4-2.1 Multiple myeloma: OR= 1.4, 95%CI= 1.0-1.8 Acute myeloid leukemia: OR= 1.4, 95% CI= 1.0-2.0 Cancers of the esophagus: OR= 1.6, 95% CI= 1.2-2.1 Prostate: OR= 1.5, 95% CI= 1.3-1.7 Brain: OR= 1.5, 95% CI= 1.2-2.0 Kidney: OR= 1.3, 95% CI= 1.0-1.6
LeMasters GK (2006) [38]	Cancer Risk Among Firefighters: A Review and Meta-analysis of 32 Studies	To review 32 studies on firefighters and to quantitatively and qualitatively determine the cancer risk using a meta-analysis.	Multiple myeloma: SRE[8]= 1.53, 95% CI= 1.21–1.94 Non-Hodgkin lymphoma: SRE= 1.51, 95% CI= 1.31–1.73 Prostate cancer: SRE= 1.28, 95% CI= 1.15–1.43 Testicular cancer: SRE = 2.02, 95% CI= 1.30–3.13 Skin: SRE= 1.39, 95% CI= 1.10–1.73 Malignant melanoma: SRE=1.32, 95% CI= 1.10–1.57 Brain: SRE=1.32, 95% CI= 1.12–1.54 Rectum: SRE= 1.29, 95% CI= 1.10–1.51 Buccal cavity and pharynx: SRE= 1.23, 95% CI= 0.96–1.55 Stomach: SRE= 1.22, 95% CI= 1.04–1.44 Colon: SRE= 1.21, 95% CI= 1.03–1.41 Leukemia: SRE= 1.14, 95% CI= 0.98–1.31
Ide CW (2014) [34]	Cancer incidence and mortality in serving whole-time Scottish firefighters 1984-2005	To determine the incidence of, and mortality from, cancer in a cohort of approximately 2200 serving full-time firefighters in Scotland, in comparison to the general population.	Overall mean annual cancer incidence rate: 86.5/100,000 population versus 123.7/100,000 population (general population, GP), 95% CI= -290.3--209.7 Overall mean annual cancer mortality rate: 20.4/100,000 population versus 59.9/100,000 population (GP), 95% CI= -57.5 - -22.5 Melanoma: 13.6/100,000 population versus 7.7/100,000 population (GP), 95% CI 3.0 - 8.8 Kidney cancer incidence: 9.1/100,000 population versus 4.4/100,000 population (GP), 95% CI 2.4 - 6.7) Kidney cancer mortality: 6.5/100,000 population versus 1.9/100,000 population (GP), 95% CI 2.8 - 6.4) Large bowel cancer: 9.1/100,000 population versus 13.8/100,000 population (GP), 95% CI -7.7 - -1.7 Lung cancer: 6.8/100,000 population versus 20.4/100,000 population (GP), 95% CI -7.7 - 1.0).

[7] All results are displayed in Appendix B, Figure 5
[8] Summary Risk Estimate

Traumatic Injury

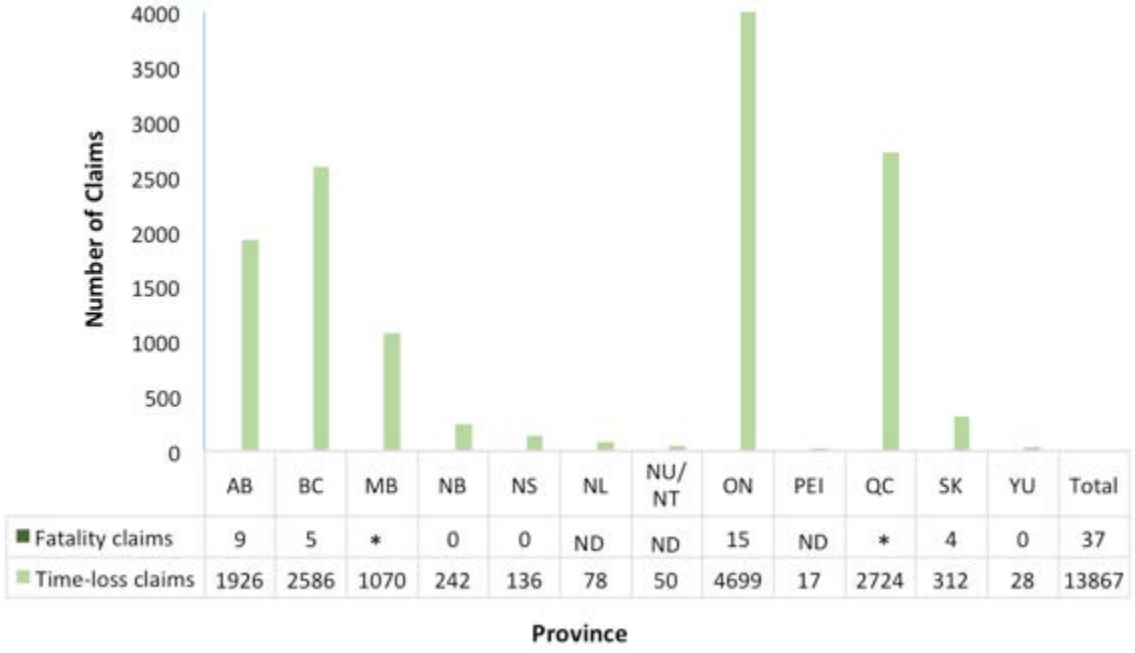
The risk for traumatic injury, a sudden physical injury that requires immediate medical attention, is well known among the firefighting occupation. The profession of firefighting is a high-hazard occupation that involves exposures to heat and intense physical activity. In addition, firefighters spend many hours in transit to get to emergency scenes, adding vehicle collision risk to their job description. In the United States in 2016 there were 15,425 collisions involving fire department emergency vehicles responding to or returning from incidents. [42]

Traumatic injury contributed to 6.5% of all fatality claims by firefighters in Canada between 2006 and 2015[9], at a rate of 4.4 fatalities per 100,000 Canadian firefighter population[10] annually. Among time-loss claims by Canadian firefighters during this period, 89.9% of claims were due to traumatic injury, at a rate of 1,661.3 per 100,000 firefighter population.

Nationally, Ontario accounted for 34% of all time-loss claims and 35% of all fatality claims related to traumatic injury (Figure 4). Alberta and Saskatchewan experienced the highest average rates of traumatic injury fatalities per firefighter population in an average year, at 9.0 and 6.3 per 100,000 firefighter population, respectively. The highest rates of time-loss claims among firefighters were in Manitoba (2,464.9 per 100,000 firefighter population), British Columbia (2,173.1 per 100,000 firefighter population) and Alberta (1,926.0 per 100,000 firefighter population) (Figure 5). The majority of fatality claims due to traumatic injury among firefighters were submitted for males over the age of 65 years. Time-loss claims for traumatic injury were highest between the ages of 35 to 49, with a very low number of claims submitted for firefighters under the age of 25 (5.5%) or over the age of 59 (7.5%) (Figure 6).

[9] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only
[10] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only

FIGURE 4: FIREFIGHTER TRAUMATIC INJURY TIME-LOSS AND FATALITY CLAIMS, BY PROVINCE, 2006-2015, AWCBC[i]

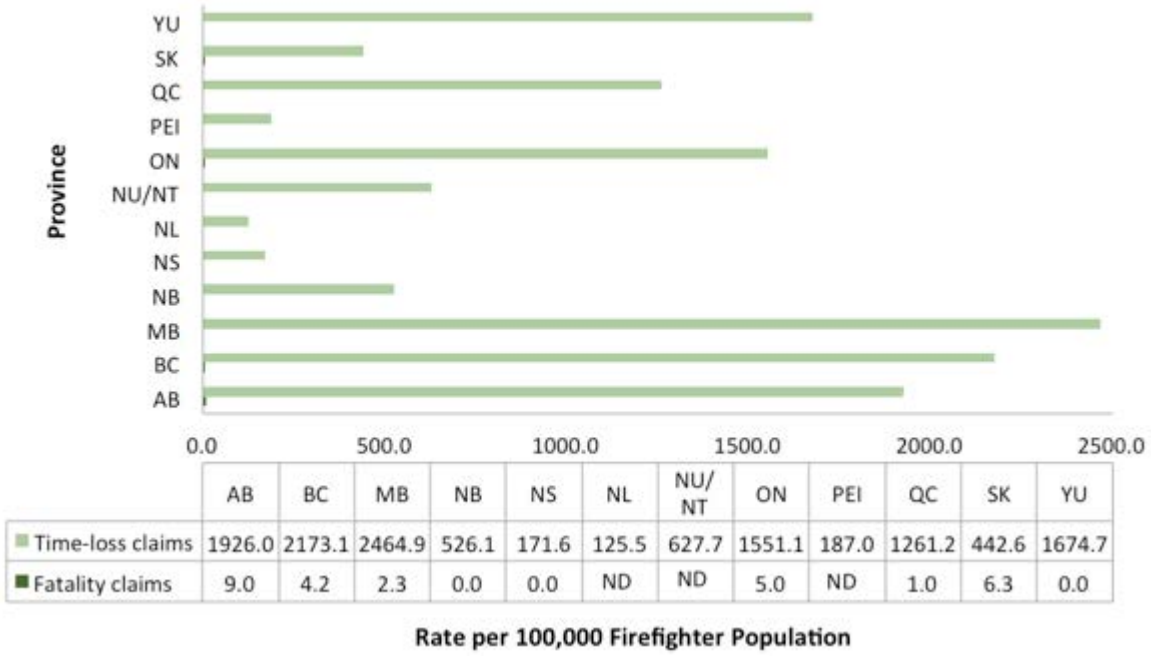


	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU	Total
Fatality claims	9	5	*	0	0	ND	ND	15	ND	*	4	0	37
Time-loss claims	1926	2586	1070	242	136	78	50	4699	17	2724	312	28	13867

*Indicates a value of 1≤ X ≤ 3

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 5: TRAUMATIC INJURY TIME-LOSS AND FATALITY CLAIMS AVERAGE ANNUAL RATES PER 100,000 FIREFIGHTER POPULATION BY PROVINCE, 2006-2015, AWCBC[i]

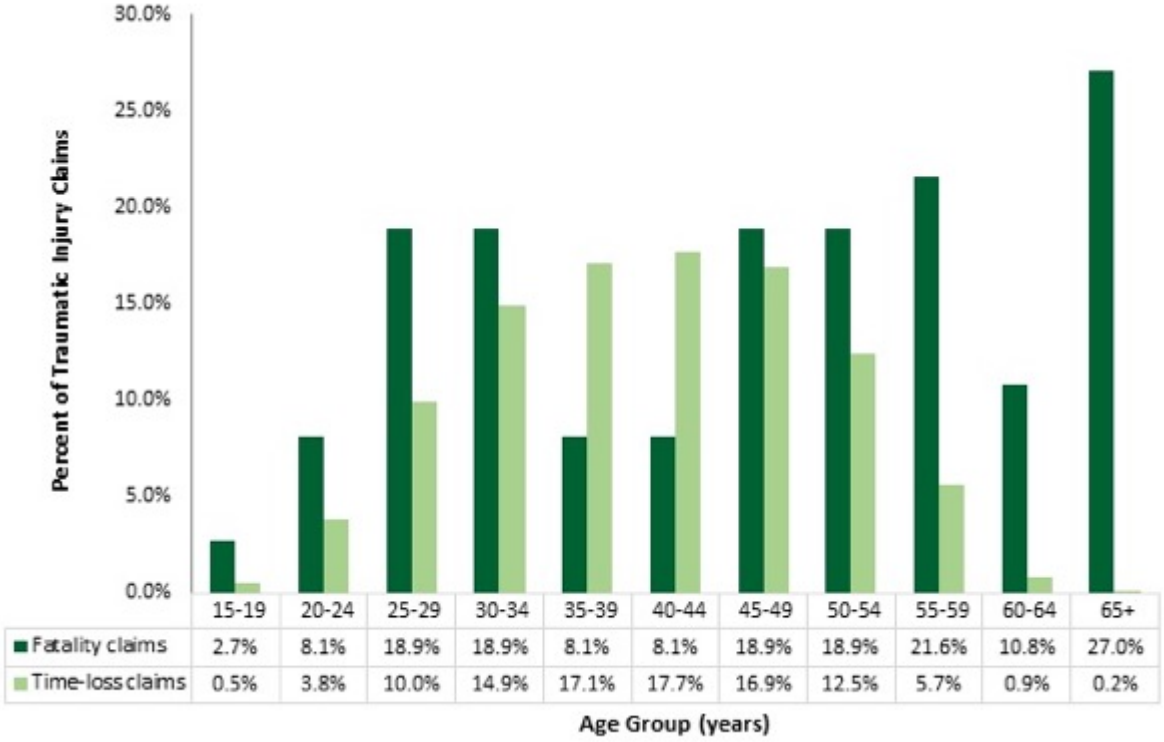


	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU
Time-loss claims	1926.0	2173.1	2464.9	526.1	171.6	125.5	627.7	1551.1	187.0	1261.2	442.6	1674.7
Fatality claims	9.0	4.2	2.3	0.0	0.0	ND	ND	5.0	ND	1.0	6.3	0.0

ND= No data provided

[i]Note: random allocation of suppressed small numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 6: PERCENT OF ALL TRAUMATIC INJURY CLAIMS, BY AGE GROUP, 2006-2015, CANADA, AWCBC



	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
Fatality claims	2.7%	8.1%	18.9%	18.9%	8.1%	8.1%	18.9%	18.9%	21.6%	10.8%	27.0%
Time-loss claims	0.5%	3.8%	10.0%	14.9%	17.1%	17.7%	16.9%	12.5%	5.7%	0.9%	0.2%

National and provincial data revealed that traumatic injury is the leading cause of time-loss claims among firefighters. In addition to the determined risk for traumatic injury incidence, the literature also demonstrated that traumatic injuries such as burns, extremity injuries and back injuries were leading causes of time off work among firefighters (Table 5). In 2012, Hong found that approximately 66% of firefighters experienced occupational injuries. [17] The most commonly reported injuries were muscle strains and sprains (74%), extremity injuries (60%), back injuries (54%), and burns (28%). Similarly a 2015 study found that the largest causal mechanism for injury was muscular stress (74 injuries per 1,000 full-time employees annually) and the principal injury type involved sprains and strains. [10] The most common forms of injury mechanism were slips, trips and falls, and equipment, tools and machinery. [11,43]

From 2002 to 2012, traumatic deaths accounted for 29.6% of all firefighter fatalities, with fatalities involving a motor vehicle collision accounting for 9.3%. [23] Firefighters have been found to report a low level assault incidence, and injuries from poisoning or environmental exposure were less likely to result in a severe injury than were slips, trips or falls. [25, 43]

TABLE 5: SELECTED ARTICLES- CAUSES OF INJURY AND DEATH AMONG FIREFIGHTERS: TRAUMATIC INJURY

Lead Authors	Title	Objective	Results
Britton C (2013) [43]	Epidemiology of injuries to wildland firefighters.	This report examined wildland firefighter injuries reported to the U.S. Department of the Interior from the years 2003 to 2007.	The most common injury mechanism was slips/trips/falls followed by equipment/tools/machinery. Injuries from poisoning or environmental exposure were less likely to lead to severe injury than slips, trips, or falls (odds ratio, 0.45; 95% confidence interval, 0.21-0.95).
Clark WW (2005) [44]	Hearing levels of firefighters: Risk of occupational noise-induced hearing loss assessed by cross-sectional and longitudinal data.	The results of annual audiometric testing and a related questionnaire, collected as part of a company-wide hearing conservation program, were obtained from two large U.S. urban fire departments.	The results of this large-scale, cross-sectional, and longitudinal study indicate that firefighters are not at risk for occupational noise-induced hearing loss, even though they work nonstandard shifts and are occasionally exposed to high levels of noise.
Hong O (2012) [17]	Occupational injuries, duty status, and factors associated with injuries among firefighters.	A total of 437 firefighters from three U.S. states participated in an Internet-based survey.	The most commonly reported injuries were muscle strains and sprains (74%), extremity injuries (60%), back injuries (54%), and burns (28%).
Hong O (2013) [45]	Hearing loss and use of hearing protection among career firefighters in the U.S.	A Web-based survey and a standard audiometric test were performed with 425 firefighters from three states in the U.S.	More than 40% showed hearing loss in the noise-sensitive frequencies (4 and 6 kHz). Firefighters having longer years of work in fire services demonstrated significantly worse hearing. Reported use of HPDs was 34% of the time that was needed.
Kahn SA (2015) [23]	Line of duty firefighter fatalities: An evolving trend over time.	To report on all-cause line of duty mortality among firefighters between 1990-2000 and 2002-2012, using the U.S Fire Administration fatality database.	Between 1990-2000, 1140 firefighters sustained a fatal injury while on duty; and 1174 were killed during 2002-2012. MI has increased from 43% to 46.5% of deaths (p=0.012) between the 2 decades. Asphyxiation has decreased from 12.1% to 7.9% (p=0.003) and burns have decreased from 7.7% to 3.9% (p=0.0004). Electrocution is down from 1.8% to 0.5% (p=0.004). Death from trauma was unchanged (27.8 to 29.6%, p=0.12). The percentage of fatalities involving an MVC has increased from 4.6 to 9.3% (p=0.0001).
Mechem CC (2002) [22]	Injuries from assaults on paramedics and firefighters in an urban emergency medical services system.	To determine the nature and frequency of injuries resulting from assaults on urban paramedics and firefighters in a large, fire department-based emergency medical services system.	There were 1,100 injury reports submitted during the study period, of which 44 (4.0%, 95% CI 0-10.9%) involved an assault. Firefighters were assaulted in nine (20.5%) of these incidents.

Lead Authors	Title	Objective	Results
Reichard AA (2009) [9]	Occupational injuries among emergency responders.	To characterize injuries among emergency medical services, firefighting, and police occupations by using data from the National Electronic Injury Surveillance System-Occupational Supplement (NEISS-Work) for injuries treated in U.S. hospital emergency departments in 2000-2001.	Sprains and strains were the leading injury (33-41%) among EMS, firefighter, and police occupations. Police officers and career firefighters had the highest injury rates (8.5 and 7.4 injuries per 100 full-time equivalent workers, respectively).
Suyama J (2009) [14]	Comparison of public safety provider injury rates.	To compare injury rates in workers' compensation data for emergency medical services (EMS), fire, and police providers from one urban center between January 1, 2005, and May 31, 2007, were examined.	A total of 1,295 workers' compensation events were documented, with 477 (36%) reported from fire. Lost time injuries were more common in fire (39%) and police (38%) than EMS (23%). Workers' compensation events common to all bureaus were minor trauma (76%) and exposures to blood-borne pathogens (12%). Minor traumatic injuries, mostly associated with axial musculoskeletal strains and extremity injuries, were responsible for the majority of injuries resulting in missed work. Injuries more common in a specific bureau included cardiovascular disease, burns, and heat illness (fire).
Taylor NA (2015) [10]	A retrospective evaluation of injuries to Australian urban firefighters (2003 to 2012): Injury types, locations, and causal mechanisms.	Work-related injury data from Australia's largest urban fire and rescue organization were analyzed from 2003 to 2012, with an emphasis on classification (occurrence, mechanism, agency, nature, and location) and demographic details.	The largest causal mechanism was muscular stress (74 injuries per 1000 full-time employees annually), with 62.1% of those incidents involving materials handling and slips, trips, and falls. The principal injury type involved sprains and strains. The most commonly injured sites were the knee, lower back, shoulder, and ankle.
Vaulerin J (2016) [19]	Physical exercise and burnout facets predict injuries in a population-based sample of French career firefighters.	Data were collected from a population-based sample of 220 male firefighters in France to describe the nature and site of injuries and the relationships among firefighter injuries, physical exercise, burnout and coping strategies.	Sprains were the most prevalent type of injury (98%), followed by tendinitis (40%) and muscle tears (30%). More than two thirds of these injuries were located at the ankle. The findings suggest that physical exercise and cognitive weariness can be considered as risk factors for French firefighter injuries.

Cardiovascular Disease

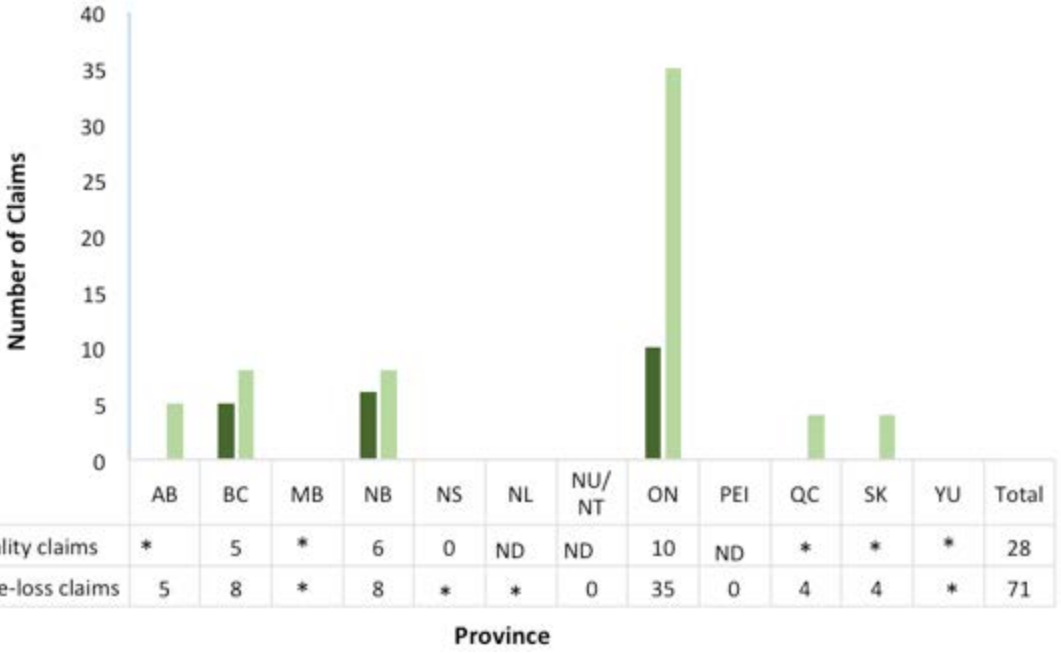
Diseases of the circulatory system, such as ischemic heart disease, myocardial infarction (heart attack), congestive heart failure and cerebrovascular disease, are identified under the broader term of cardiovascular disease. [46] Cardiovascular disease is the leading cause of on-duty death among firefighters. [47] The physical demands, emotional stress and environmental hazards that a firefighter endures on the job place stress on the cardiovascular system. [48] Among firefighters employed in the United States, coronary heart disease is responsible for 45% of on-duty deaths. [49]

Cardiovascular disease contributed to 4.9% of all fatality claims by firefighters in Canada between 2006 and 2015[11], at a rate of 2.9 fatalities per 100,000 Canadian firefighter population[12] annually. Among time-loss claims by Canadian firefighters, 0.5% of claims between 2006 and 2015 were due to cardiovascular disease. Yearly time-loss claims for cardiovascular disease among firefighters occurred at a rate of 6.5 per 100,000 firefighter population.

Nationally, Ontario accounted for 49% of all time-loss claims and 36% of all fatality claims related to cardiovascular disease (Figure 7). The Yukon and New Brunswick experienced the highest average rates of cardiovascular disease fatalities per firefighter population in an average year, at 579.7 and 21.7 per 100,000 firefighter population, respectively. However, the high rate of cardiovascular disease fatalities in the Yukon can be accounted for by an extremely low firefighter population. The highest rates of time-loss claims among firefighters were in the Yukon (32.2 per 100,000 firefighter population), New Brunswick (17.4 per 100,000 firefighter population) and Ontario (11.6 per 100,000 firefighter population) (Figure 8). The highest proportion of fatality claims due to cardiovascular disease among firefighters was among males between the ages of 55-59 years (28.6%). Time-loss claims from cardiovascular disease occurred most frequently between the ages of 55-59 (23.9%), with very low number of claims submitted for males under the age of 30 (0.0%) (Figure 9).

[11] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only
[12] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only

FIGURE 7: FIREFIGHTER CARDIOVASCULAR DISEASE TIME-LOSS AND FATALITY CLAIMS, BY PROVINCE, 2006-2015, AWCBC[i]

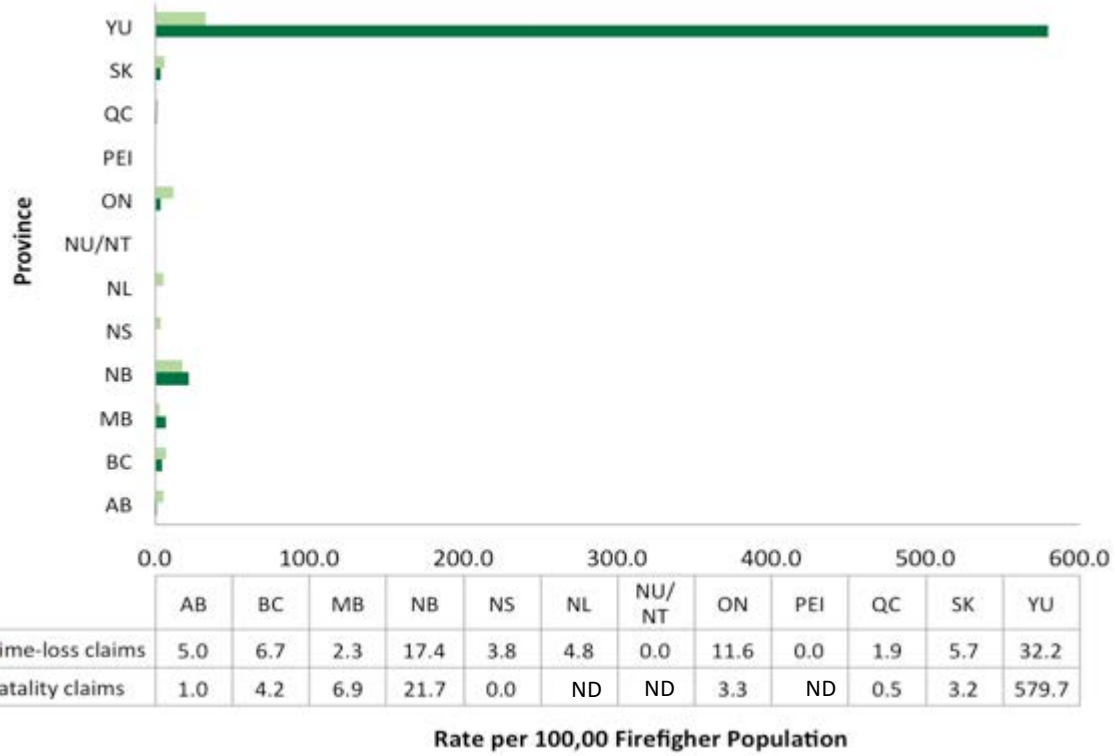


	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU	Total
Fatality claims	*	5	*	6	0	ND	ND	10	ND	*	*	*	28
Time-loss claims	5	8	*	8	*	*	0	35	0	4	4	*	71

*Indicates a value of 1≤ X ≤ 3

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 8: CARDIOVASCULAR DISEASE TIME-LOSS AND FATALITY CLAIMS AVERAGE ANNUAL RATES PER 100,000 FIREFIGHTER POPULATION BY PROVINCE, 2006-2015, AWCBC[i]

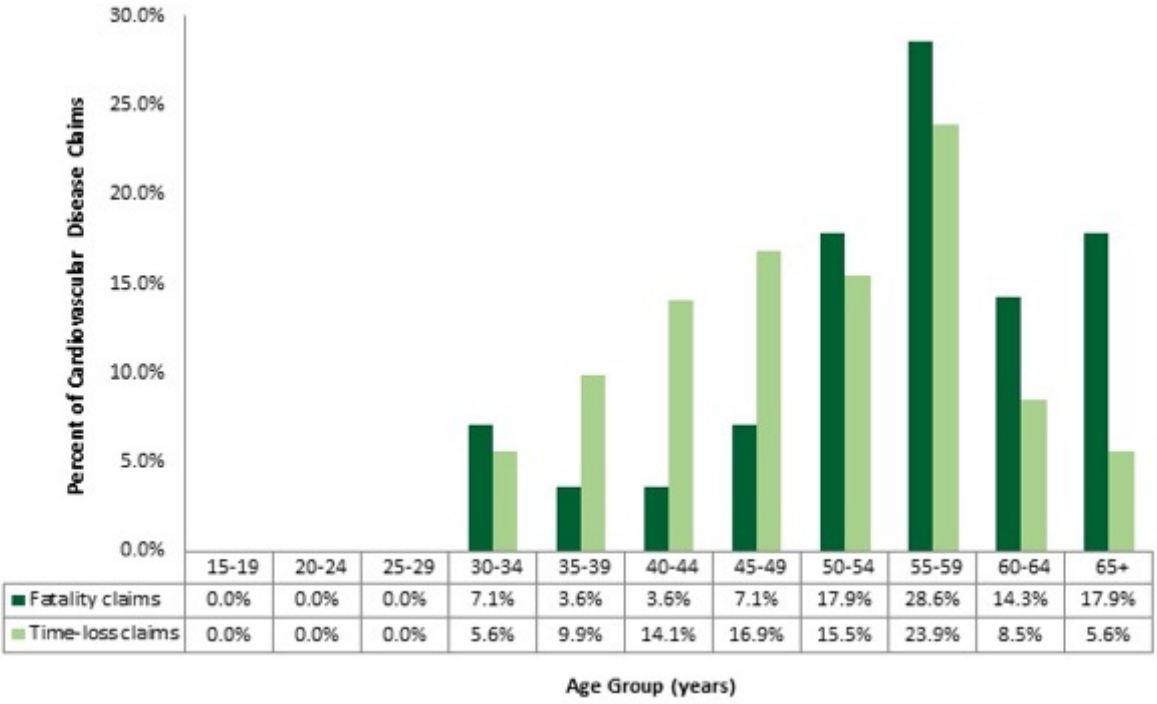


	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU
Time-loss claims	5.0	6.7	2.3	17.4	3.8	4.8	0.0	11.6	0.0	1.9	5.7	32.2
Fatality claims	1.0	4.2	6.9	21.7	0.0	ND	ND	3.3	ND	0.5	3.2	579.7

ND= No data provided

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 9: PERCENT OF ALL CARDIOVASCULAR DISEASE CLAIMS, BY AGE GROUP, 2006-2015, CANADA, AWCBC



	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
Fatality claims	0.0%	0.0%	0.0%	7.1%	3.6%	3.6%	7.1%	17.9%	28.6%	14.3%	17.9%
Time-loss claims	0.0%	0.0%	0.0%	5.6%	9.9%	14.1%	16.9%	15.5%	23.9%	8.5%	5.6%

Cardiovascular disease was identified in the literature as a leading cause of mortality among firefighters in Canada and other similar countries (Table 6). Sen reported that out of a 10-year time period, 1,153 firefighter fatalities were recorded, of which 47% were cardiac fatalities. [50]

Tasks with the greatest risk for sudden cardiac death included fire suppression (relative risk, RR= 22.1), physical training (RR=4.8), alarm return (RR= 4.1) and alarm response (RR=2.6). [51] In comparison to the odds of death from coronary heart disease during nonemergency duties, the odds were 12.1 to 136 times higher during fire suppression, 2.8 to 14.1 times higher during alarm response, 2.2 to 10.5 times higher during alarm return, and 2.9 to 6.6 times as high during physical training. [52] Volunteer firefighters suffered a higher proportion of cardiac fatalities in comparison to professional firefighters. However, both career and volunteer firefighters are at a significantly higher risk of a fatal cardiac event as they age.

A 2009 study found that firefighters do not appear to be at increased risk for cardiovascular death. [53] A 2015 study found similar results; the overall sudden cardiac death incidence risk of 18.1 per 100,000 person-years was lower than the general population. [54]

TABLE 6: SELECTED ARTICLES- CAUSES OF INJURY AND DEATH AMONG FIREFIGHTERS: CARDIOVASCULAR DISEASE

Lead Authors	Title	Objective	Results
Drew-Nord DC (2009) [53]	Cardiovascular risk factors among career firefighters.	The purpose of this study was to identify cardiovascular disease risk factors among professional firefighters in North America through an extensive literature review.	Cardiovascular risk profiles of firefighters are similar to those of the general population. The literature indicates that firefighters do not appear to be at increased risk for cardiovascular death. The overall data do not suggest that firefighters are at increased risk for CVD.
Farioli A (2014) [51]	Duty-related risk of sudden cardiac death among young US firefighters.	To investigate duty-related sudden cardiac death among U.S. firefighters aged 45 or younger.	SCD risk - fire suppression: RR = 22.1, 95% CI= 14.8-32.9 SCD risk -alarm response: RR= 2.6, 95% CI= 1.5-4.6 SCD risk - alarm return: RR= 4.1, 95% CI= 2.7-6.2 SCD risk -physical training: RR= 4.8, 95% CI= 3.2-7.2
Farioli A (2015) [54]	Incidence of sudden cardiac death in a young active population.	This study investigated the incidence of sudden cardiac death among U.S. male career firefighters.	Overall SCD: IR=18.1 per 100 000 person-years SCD (18 to 24 years): IR= 3.8 per 100 000 person-years SCD (55 to 64 years): IR= 45.2 per 100 000 person-years IRs among firefighters were lower than those observed among the US general population and US military personnel.
Kales SN (2007) [52]	Emergency duties and deaths from heart disease among firefighters in the U.S.	This study examined duty-specific risks of death from coronary heart disease among on-duty U.S. firefighters from 1994 to 2004.	SCD % - fire suppression: 32.1% SCD % -alarm response: 13.4% SCD % - alarm return: 17.4% SCD % -physical training: 12.5% SCD %- non-fire emergencies: 9.4% SCD %- nonemergency duties: 15.4% As compared with the odds of death from coronary heart disease during nonemergency duties, the odds were 12.1 to 136 times as high during fire suppression, 2.8 to 14.1 times as high during alarm response, 2.2 to 10.5 times as high during alarm return, and 2.9 to 6.6 times as high during physical training.

Lead Authors	Title	Objective	Results
Kales SN (2003) [55]	Firefighters and on-duty deaths from coronary heart disease: A case control study.	We sought to identify occupational and personal risk factors associated with on-duty coronary heart disease death.	SCD risk - fire suppression: OR = 64.1, 95% CI= 7.4-556 SCD risk -alarm response: OR = 5.6, 95% CI= 1.1-28.8 SCD risk - alarm return: OR= 3.4, 95% CI= 0.8-14.7 SCD risk -physical training: OR = 7.6, 95% CI= 1.8-31.3
Sen S (2016) [50]	Cardiac fatalities in firefighters: An analysis of the U.S. fire administration database.	This study analyzed the Firefighter Fatalities and Statistics data collected by the U.S. Fire Administration from January 2002 to December 2012 to determine associations between age, firefighter classification, duty-type, and cause of fatal cardiac event.	A total of 1153 firefighter fatalities occurred during the 10-year period reviewed. Of these, 47% were cardiac fatalities. Volunteer firefighters suffered significantly higher proportion of cardiac fatalities (62%; P <.05) followed by career firefighters (32%). Additionally, cardiac fatalities were the leading cause of death for volunteer firefighters (54%; P <.05). The highest proportion of cardiac fatalities occurred on-the-scene (29%; P <.05) followed by after-duty fatalities (25%). Stress and overexertion accounted for 98% of the cause of cardiac fatalities.
Wolkow A (2014) [56]	Coronary heart disease risk in volunteer firefighters in Victoria, Australia.	This study predicted the absolute coronary heart disease risk in Australian volunteer firefighters and compare the prevalence of individual coronary heart disease risk factors in firefighters with age- and sex-matched Australian population data.	CHD risk (males): 19.2% CHD risk (female): 5.1% **Male** CHD risk (30-24): Mean RR: 0.6 CHD risk (35-39): Mean RR: 0.8 CHD risk (40-44): Mean RR: 1.7 CHD risk (45-49): Mean RR: 3.9 CHD risk (50-54): Mean RR: 3.8 CHD risk (55-59): Mean RR: 4.3 CHD risk (60-64): Mean RR: 3.9 CHD risk (65-69): Mean RR: 3.0 CHD risk (70-74): Mean RR: 2.4 **Female** CHD risk (30-24): Mean RR: 1.0 CHD risk (35-39): Mean RR: 1.5 CHD risk (40-44): Mean RR: 1.2 CHD risk (45-49): Mean RR: 1.3 CHD risk (50-54): Mean RR: 1.4 CHD risk (55-59): Mean RR: 1.2 CHD risk (60-64): Mean RR: 1.4 CHD risk (65-69): Mean RR: 1.0 CHD risk (70-74): Mean RR: 1.4

Lead Authors	Title	Objective	Results
Yang J (2013) [57]	Sudden cardiac death among firefighters <=45 years of age in the U.S.	To describe the specific pathologic-anatomic causes of on-duty sudden cardiac death, compare the prevalence and severity of cardiovascular disease risk factors in sudden cardiac death fatalities with those in healthy, occupationally active firefighter controls, and compare the cardiac findings from the sudden cardiac death cases at autopsy with those of firefighters who died of on-duty on-cardiac causes.	History of CVD, CHD, CHD equivalent or valvular disease: OR= 6.89, 95% CI= 2.87-16.5 Irregular rhythm: OR= 0.13, 95% CI= 0.02-1.06 Abnormal findings on ECG: OR= 0.50, 95% CI= 0.16-1.59 Chest pain or shortness of breath: OR=1.92, 95% CI= 0.46-8.01

Respiratory Disease

Firefighters may experience occupational exposure to many chemicals, gases and other substances with negative health effects on the respiratory system. These risks are well known and fire departments across Canada recognize the importance of breathing apparatus use and protective equipment to minimize exposure to harmful inhalants. Examples of respiratory diseases that firefighters are at risk for include bronchitis, pneumonia, tuberculosis, asthma, chronic obstructive lung disease, lung cancer and mesothelioma[13]. Many of these diseases have latent effects and do not manifest until many years after initial exposure.

Respiratory disease contributed to 1.8% of all fatality claims by firefighters in Canada between 2006 and 2015[14], at a rate of 1.4 fatalities per 100,000 Canadian firefighter population[15] annually. Among time-loss claims by Canadian firefighters, 0.2% of claims between 2006 and 2015 were due to respiratory disease. Yearly time-loss claims for respiratory disease among firefighters occurred at a rate of 3.0 per 100,000 firefighter population.

Among Canadian firefighters between 2006 and 2015, 29% of all time-loss claims and 40% of all fatality claims related to respiratory disease were submitted in Alberta (Figure 10). Alberta and Saskatchewan experienced the highest average rates of respiratory disease fatalities in an average year, at 4.0 and 1.6 per 100,000 firefighter population respectively. The highest rates of time-loss claims among firefighters were in Nunavut/Northwest Territories (12.6 per 100,000 firefighter population), Alberta (10.0 per 100,000 firefighter population) and Quebec (5.1 per 100,000 firefighter population) (Figure 11). All fatality claims due to respiratory disease among firefighters were submitted for males over the age of 65 years. Time-loss claims from respiratory disease peaked occurred most frequently among firefighters over 65 years (20.6%) and between the ages of 25-29 (14.7%) (Figure 12).

[13] In this report, lung cancer and mesothelioma are classified under cancer.
[14] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only
[15] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only

FIGURE 10: FIREFIGHTER RESPIRATORY DISEASE TIME-LOSS AND FATALITY CLAIMS, BY PROVINCE, 2006-2015, AWCBC[i]

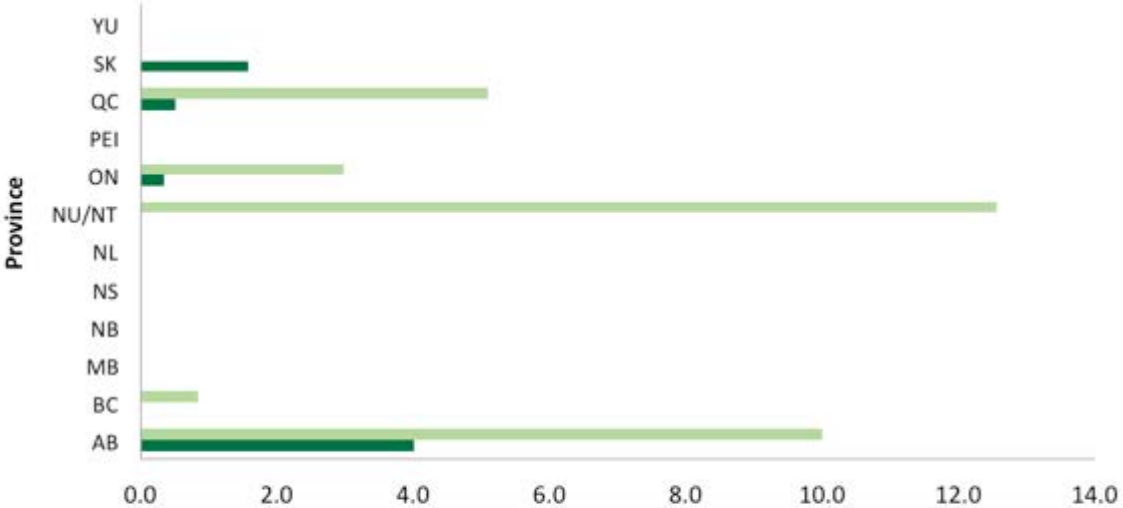
	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU	Total
Fatality claims	4	0	0	0	0	ND	ND	*	ND	*	*	0	10
Time-loss claims	10	*	0	0	0	0	*	9	0	11	0	0	34

Province

*Indicates a value of 1≤ X ≤ 3

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 11: RESPIRATORY DISEASE TIME-LOSS AND FATALITY CLAIMS AVERAGE ANNUAL RATES PER 100,000 FIREFIGHTER POPULATION BY PROVINCE, 2006-2015, AWCBC[i]



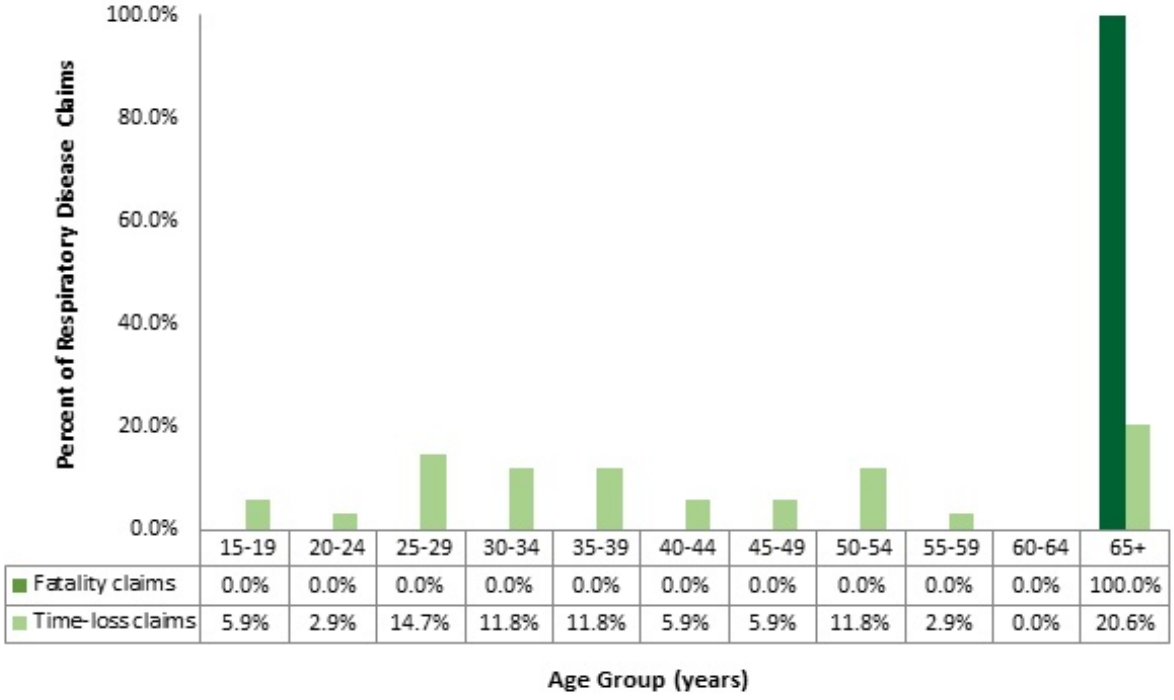
	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU
Time-loss claims	10.0	0.8	0.0	0.0	0.0	0.0	12.6	3.0	0.0	5.1	0.0	0.0
Fatality claims	4.0	0.0	0.0	0.0	0.0	ND	ND	0.3	ND	0.5	1.6	0.0

Rate per 100,000 Firefighter Population

ND= No data provided

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 12: PERCENT OF RESPIRATORY DISEASE CLAIMS, BY AGE GROUP, 2006-2015, CANADA, AWCBC



	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
Fatality claims	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Time-loss claims	5.9%	2.9%	14.7%	11.8%	11.8%	5.9%	5.9%	11.8%	2.9%	0.0%	20.6%

While respiratory disease is not a primary cause of death or injury among firefighters, it remains a leading negative health outcome (Table 7). Henneberger studied 44,423 occupational inhalation cases from hospital emergency departments in the United States from 1995 to 1996, with the highest rates seen for public administration workers (including firefighters and police officers) at a rate of 16.4 cases per 100,000 worker population per year. [58] In contrast, Amadeo found that diseases of the respiratory system were considerably lower among firefighters (SMR=0.57). [26] In two studies by Schermer, the effect of employment as a firefighter on lung function and chronic respiratory conditions was examined. [57,58] Firefighters over the age of 45 years showed increasing first forced expiratory volume (FEV1) and forced vital capacity (FVC) values over time. Firefighters who rarely used, or never used, respiratory protection had higher odds of FEV1 decline compared with those who use respiratory protection often. [59] Overall, 4% of firefighters satisfied the criteria for asthma and 7% satisfied the criteria for COPD, emphysema and/or chronic bronchitis. [60]

TABLE 7: SELECTED ARTICLES- CAUSES OF INJURY AND DEATH AMONG FIREFIGHTERS: RESPIRATORY DISEASE

Lead Authors	Title	Objective	Results
Schermer TR (2013) [59]	Change in lung function over time in male metropolitan firefighters and general population	Within the professional South Australian firefighter cohort, risk of accelerated decline was compared between subgroups based on use of	Controls showed similar mean annual declines for FEV1 and FVC across age categories, whereas firefighters aged <45 years showed increasing values over time (p=0.040). Firefighters had a lower odds of accelerated FEV1 decline compared with controls (OR=0.60, 95%CI 110.44; 0.83), but firefighters who never or rarely used

Lead Authors	Title	Objective	Results
	controls: a 3-year follow-up study.	respiratory protection devices.	respiratory protection during fire knockdown had a higher odds of accelerated FEV1 decline compared with those who used it often or frequently (OR=2.20, 95%CI 1.02; 4.74).
Schermer TR (2014) [60]	Chronic respiratory conditions in a cohort of metropolitan firefighters: associations with occupational exposure and quality of life.	To provide a cross-sectional cohort analysis on respiratory symptoms, medical conditions, occupational tasks and exposures and consistency of using respiratory protection among South Australian professional firefighters.	24 (4%) fulfilled the criteria for asthma, 39 (7%) for COPD/emphysema/chronic bronchitis. Firefighters with asthma were older than those in the other two subgroups and had been employed in the fire service longer. Respiratory subgroups did not differ in their involvement in fire-fighting tasks. Ninety-one percent of firefighters reported relevant occupational exposure in the past year. Mean PCS-12 scores for firefighters with no chronic respiratory conditions, asthma and COPD/emphysema/bronchitis were 52.0 (SD 6.9), 47.0 (8.5) and 48.1 (9.4). For PCS-12 (but not for MCS-12), interaction between having a chronic respiratory condition and inconsistent use of respiratory protection during fire knockdown was observed ($p < 0.001$).
Henneberger PK (2000) [58]	Nonfatal work-related inhalations: surveillance data from hospital emergency departments, 1995-1996.	To analyze data from the National Electronic Injury Surveillance System (NEISS) on all work-related injuries and illnesses, regardless of product involvement, in the U.S.	There were an estimated 44,423 occupational inhalation cases nationwide, with an annual rate of 3.6 cases/10(4) workers/year. The rate for men (4.4 cases/10(4)) was greater than that observed for women (2.6 cases/10(4)), and the rates tended to decline with increasing age. An estimated 4.6% of the cases were hospitalized for further treatment. The highest rate by industry was 16.4 cases/10(4) for public administration (which included fire and police departments). Among non-firefighters, there were an estimated 6,470 cases nationwide in which respiratory symptoms or conditions were noted, which yielded an annual rate of 0.5 cases/10(4) (95% CI 0.3, 0.7). Chlorine compounds were a common agent for the cases with adverse respiratory outcomes.
Amadeo B (2015) [26]	French firefighter mortality: analysis over a 30-year period.	Standardized mortality ratios were calculated for 10,829 French professional male firefighters employed in 1979 and compared with the French male population between 1979-2008.	One thousand six hundred forty two deaths were identified, representing significantly lower all-cause mortality than in the general population (SMR=0.81; 95%CI: 0.77-0.85). We observed lower all and leading-cause mortality likely due to the healthy worker effect in this cohort, with diseases of the respiratory system considerably lower (SMR=0.57).

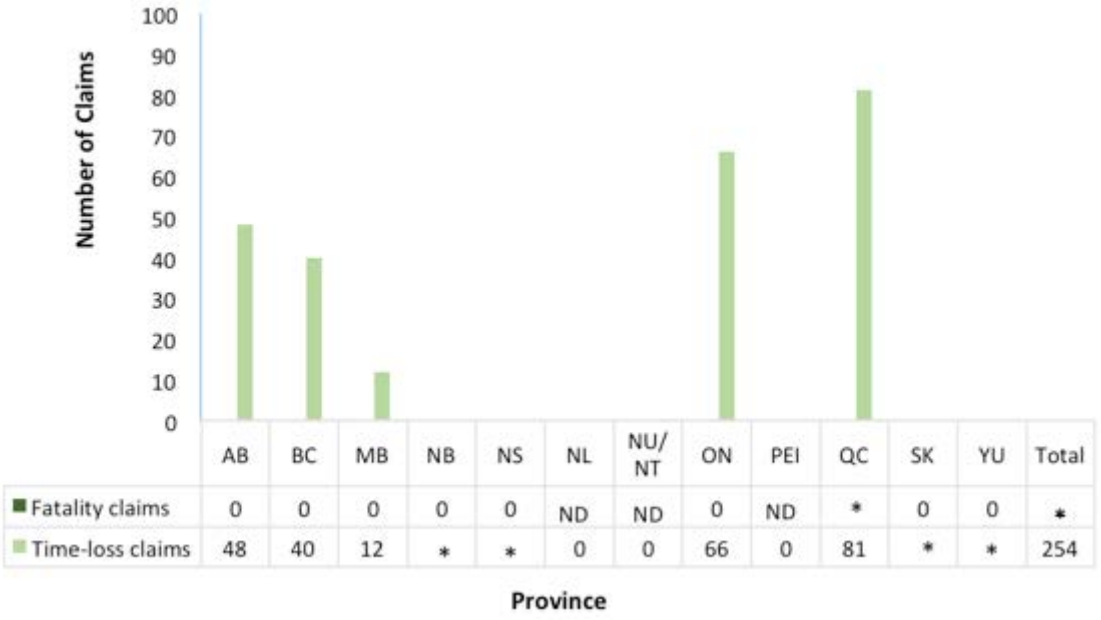
Mental Health

First responders across Canada are at an increased risk for developing a mental disorder relative to the general population, with an estimated 44.5% experiencing a symptom consistent with one or more mental disorders. [61] Through the span of a long career, firefighters are often exposed to multiple traumatic events that can impact their mental health.

Mental health contributed to 0.35% of all fatality claims by firefighters in Canada between 2006 and 2015[16], at an annual rate of 0.2 fatalities per 100,000 Canadian firefighter population[17]. Among time-loss claims by Canadian firefighters, 1.5% of claims between 2006 and 2015 were due to mental health issues. Yearly time-loss claims for mental health among firefighters occurred at a rate of 30.3 per 100,000 firefighter population.

Nationally, Quebec accounted for 32% of all time-loss claims related to mental health (Figure 13). The highest rates of mental health time-loss claims among firefighters were in Alberta (48.0 per 100,000 firefighter population), British Columbia (33.6 per 100,000 firefighter population) and Manitoba (27.6 per 100,000 firefighter population) (Figure 14). Over half of all time-loss claims for mental health were among firefighters between the ages of 25-39 years (55.1%) (Figure 15).

FIGURE 13: FIREFIGHTER MENTAL HEALTH TIME-LOSS AND FATALITY CLAIMS, BY PROVINCE, 2006-2015, AWCBC[i]



	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU	Total
Fatality claims	0	0	0	0	0	ND	ND	0	ND	*	0	0	*
Time-loss claims	48	40	12	*	*	0	0	66	0	81	*	*	254

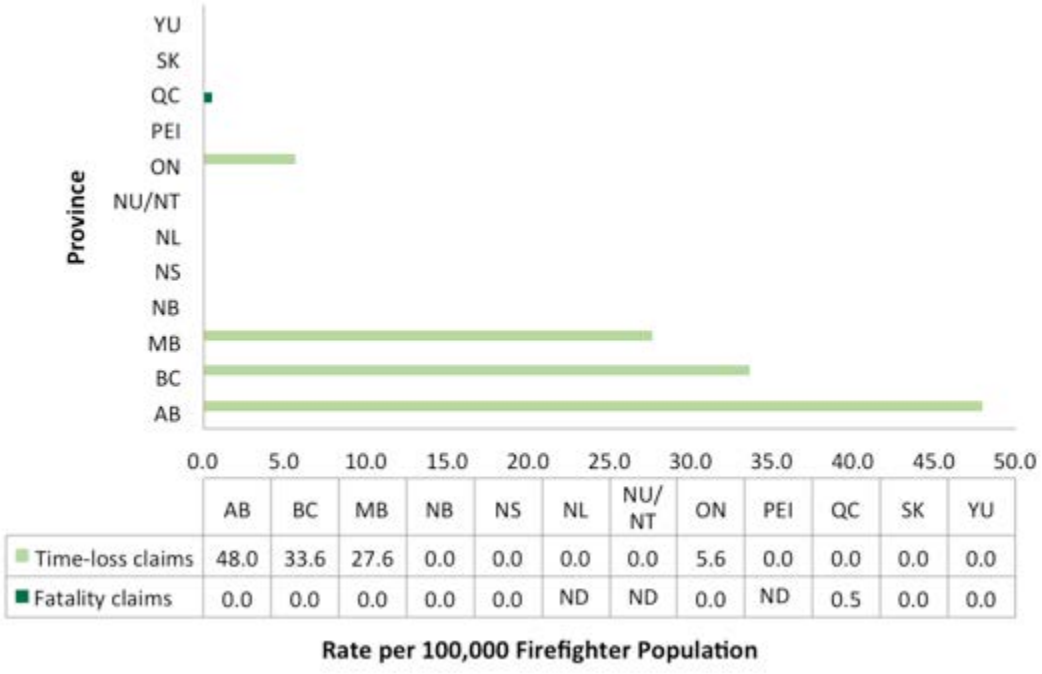
*Indicates a value of 1≤ X ≤ 3

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

[16] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only

[17] Includes data from AB, BC, MB, NB, NS, ON, QC, SK, YU only

FIGURE 14: MENTAL HEALTH TIME-LOSS AND FATALITY CLAIMS AVERAGE ANNUAL RATES PER 100,000 FIREFIGHTER POPULATION BY PROVINCE, 2006-2015, AWCBC[i]

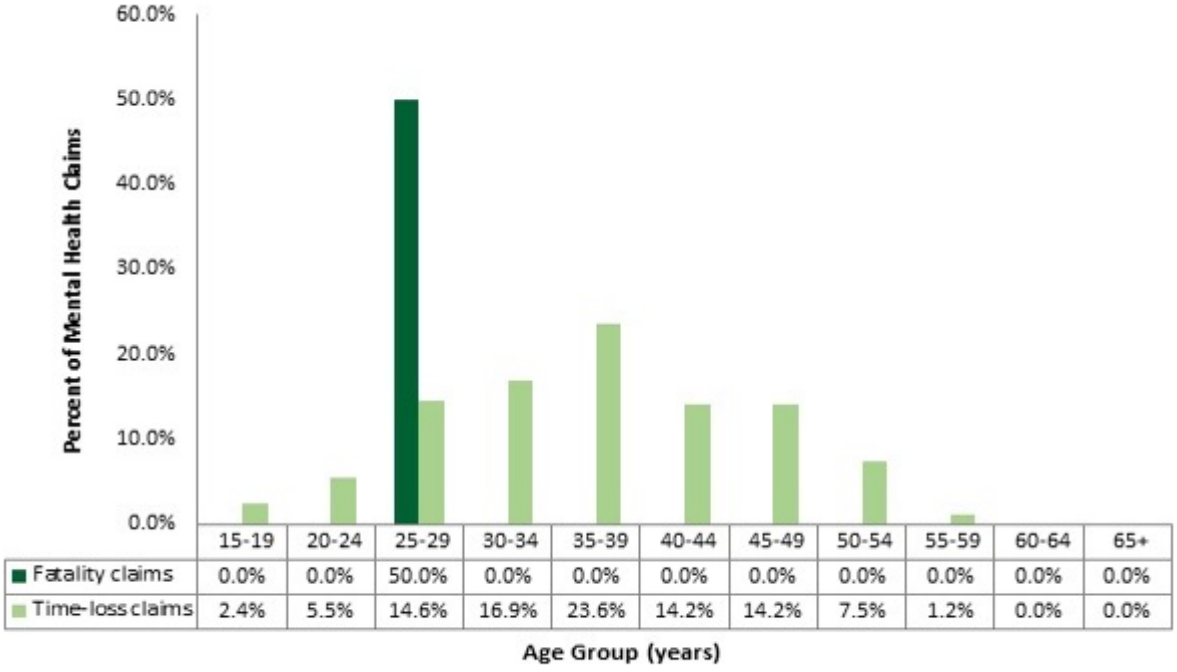


	AB	BC	MB	NB	NS	NL	NU/NT	ON	PEI	QC	SK	YU
Time-loss claims	48.0	33.6	27.6	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0
Fatality claims	0.0	0.0	0.0	0.0	0.0	ND	ND	0.0	ND	0.5	0.0	0.0

ND= No data provided

[i]Note: random allocation of suppressed small numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

FIGURE 15: PERCENT OF MENTAL HEALTH CLAIMS, BY AGE GROUP, 2006-2015, CANADA, AWCBC[i]



	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
Fatality claims	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Time-loss claims	2.4%	5.5%	14.6%	16.9%	23.6%	14.2%	14.2%	7.5%	1.2%	0.0%	0.0%

[i]Note: random allocation of suppressed numbers was completed; therefore the numbers represented here may not reflect the true numbers from the raw data. Refer to Appendix A for further information.

Mental health is an emerging issue within the field of emergency responders, resulting in a substantial amount of time off work (Table 8). It is quickly becoming a leading cause of time-loss claims among firefighters due to issues such as anxiety, post-traumatic stress disorder (PTSD) and depression. A study of 3,289 firefighters found that 13% of participants met the diagnostic criteria for PTSD symptoms and 20% met Maslach's criteria, which are comprised of three dimensions of burnout: emotional exhaustion, depersonalization and personal accomplishment. [13] Qualitative survey questions revealed that the top traumatic events among firefighters involved the death or rescue of a child. The top internal stress factors resulting in PTSD were a pre-existing health condition and prior personal trauma, while the top external stress factors were pressure from others and insufficient technique. [13] In a sample of male firefighters from Brazil, 5.5% reported symptoms of depression, with depression being more common among firefighters who reported post-traumatic stress symptoms (OR = 12.47) and alcohol abuse (OR = 5.30). [62]

TABLE 8: SELECTED ARTICLES- CAUSES OF INJURY AND DEATH AMONG FIREFIGHTERS: MENTAL HEALTH

Lead Authors	Title	Objective	Results
Carey MG (2011) [63]	Sleep problems, depression, substance use, social bonding, and quality of life in professional firefighters.	Measures assessing sleep, depression, substance use, social bonding, and quality of life were examined in 112 U.S. professional firefighters.	Sleep deprivation: 59% Binge drinking behaviour: 58% Poor mental well-being: 21% Current nicotine use: 20% Hazardous drinking behaviour: 14% Depression: 11% Poor physical well-being: 8% Caffeine overuse: 5% Poor social bonding: 4%
Katsavouni F (2016) [13]	The relationship between burnout, PTSD symptoms and injuries in firefighters.	To examine the correlation between work-related injuries, burnout and post-traumatic stress disorder symptoms in firefighters.	PTSD: 13% Burnout: 20%
Kaufmann CN (2013) [64]	Mental health of protective services workers: results from the national epidemiologic survey on alcohol and related conditions.	To determine the prevalence of mental disorders in a nationally representative sample of U.S. protective services workers (PSW), compare it to that of adults in other occupations, and determine if an association exists between trauma exposure and 3-year incident psychiatric disorders in PSWs.	Alcohol abuse and dependence: 37% Depressive episodes: 15%
Stanley IH (2016) [65]	Suicide mortality among firefighters: results from a large, urban fire department.	This study aimed to describe suicide rates within the Philadelphia Fire Department (U.S.) fire department and compare firefighter suicide rates with demographically adjusted general population suicide rates.	Overall, 272 deaths were recorded; 11 (4.0%) were certified as suicides. The overall suicide rate among firefighter affiliates of the PFD between 1993 and 2014 was 11.61 per 100,000 person-years. The suicide rate among firefighters appears comparable to, and perhaps lower than,

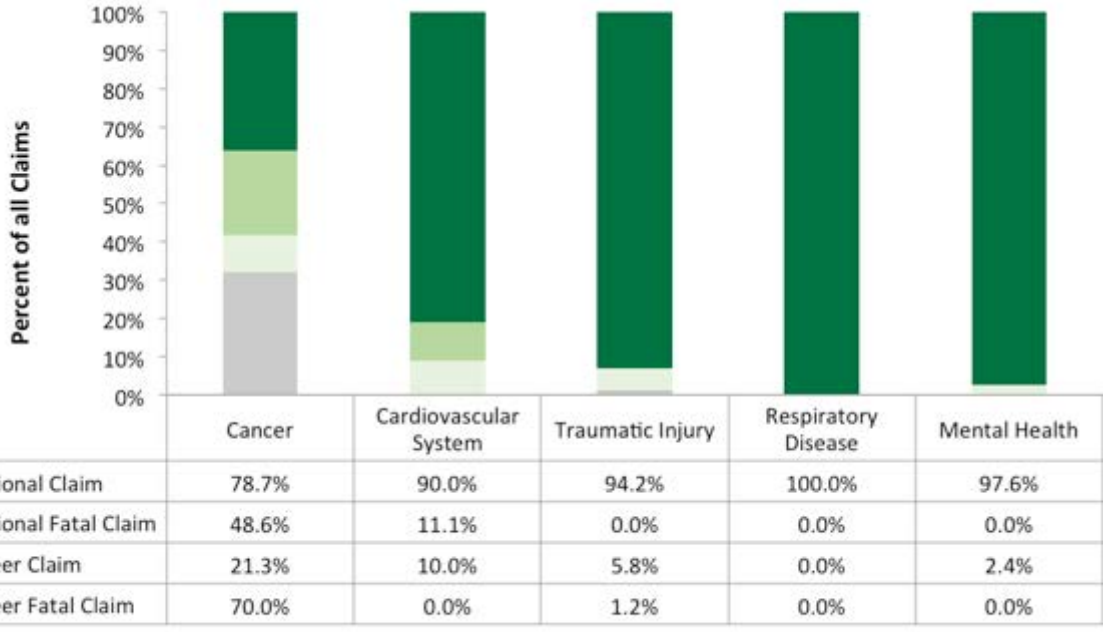
Lead Authors	Title	Objective	Results
			demographically adjusted general population estimates.
Stanley IH (2015) [66]	Career prevalence and correlates of suicidal thoughts and behaviors among firefighters.	The purpose of this study is to describe the career prevalence of suicide ideation, plans, attempts, and non-suicidal self-injury among U.S. firefighters, in addition to socio-demographic, physical health, and occupational correlates.	Career prevalence estimates of: Suicide ideation: 46.8% Suicide plans: 19.2% Suicide attempts: 15.5% Non-suicidal self-injury: 16.4% Key factors associated with increased risk for reporting suicidal thoughts and behaviors included lower firefighter rank, fewer years of firefighter service, membership in an all-volunteer department, a history of professionally responding to a suicide attempt or death, and active duty military status.
Stanley IH (2017) [67]	Suicidal thoughts and behaviors among women firefighters: An examination of associated features and comparison of pre-career and career prevalence rates.	The purpose of this study is to describe and compare pre-career and career rates of suicidal thoughts and behaviors and identify socio-demographic and occupational correlations among women firefighters in the U.S.	Pre-career rates of: Suicide ideation: 28.4% Suicide plans: 10.2% Suicide attempts: 5.8% Non-suicidal self-injury: 11.2% Career rates of: Suicide ideation: 37.7% Suicide plans: 10.9% Suicide attempts: 3.5% Non-suicidal self-injury: 9.3% Pre-career rates of: Suicide ideation: OR = 4.760, 95% CI = 2.820-8.034 Suicide plans: OR = 4.867, 95% CI = 2.067-11.463 Suicide attempts: OR = 7.175, 95% CI = 1.726-29.828 NSSI: OR = 9.676, 95% CI = 4.130-22.670 *all significantly associated with career suicidality Women firefighters report elevated rates of suicidal thoughts and behaviors. Suicidal symptoms occurring prior to one's tenure as a firefighter-and not solely an aspect of firefighter career experiences

Volunteer Status

The AWCBC data received for analysis did not include a variable for status of employment of firefighters; therefore it was not possible to differentiate the determinants of injury and death between volunteer, part-time professional and full-time professional firefighters on a national scale. The WorkSafeBC data were further analyzed to complement the national dataset and provide information on employment status of firefighters in relation to cause of injury and death.

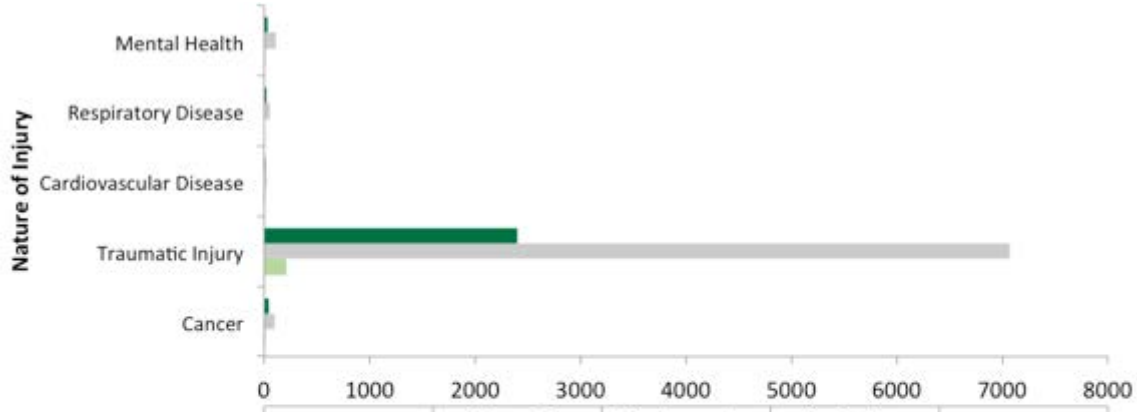
Among British Columbian firefighters, 21.3% of all claims related to cancer were submitted by volunteer firefighters. Among volunteer firefighters who submitted occupational claims related to cancer, 70% were fatality claims (Figure 16). The rate of traumatic injury among volunteer firefighters in British Columbia was 204.9 per 100,000 firefighter population, which was lower than the rate among professional firefighters (7,065.8 per 100,000 firefighter population). For other primary causes of injury and death among firefighters in British Columbia, rates of injury and disease were higher among professional firefighters than among volunteer firefighters (Figure 17).

FIGURE 16: PROPORTION OF VOLUNTEER FIREFIGHTERS, PROFESSIONAL FIREFIGHTERS AND FATAL CLAIMS, BY CAUSE, 2006-2015, BRITISH COLUMBIA, WORKSAFEBC



	Cancer	Cardiovascular System	Traumatic Injury	Respiratory Disease	Mental Health
Professional Claim	78.7%	90.0%	94.2%	100.0%	97.6%
Professional Fatal Claim	48.6%	11.1%	0.0%	0.0%	0.0%
Volunteer Claim	21.3%	10.0%	5.8%	0.0%	2.4%
Volunteer Fatal Claim	70.0%	0.0%	1.2%	0.0%	0.0%

FIGURE 17: AVERAGE ANNUAL OCCUPATIONAL INJURY CLAIMS RATES PER 100,000 FIREFIGHTER POPULATION, BY NATURE OF INJURY AND EMPLOYMENT STATUS, 2006-2015, BRITISH COLUMBIA, WORKSAFEBC



	Cancer	Traumatic Injury	Cardiovascular Disease	Respiratory Disease	Mental Health
Total	39.5	2395.8	8.4	17.6	34.5
Professional	97.4	7065.8	23.7	55.3	105.3
Volunteer	12.3	204.9	1.2	0	1.2

Rate per 100,000 Firefighter Population

Discussion

Cancer, traumatic injury, cardiovascular disease and respiratory disease are the leading causes of accepted fatality claims among Canadian firefighters. In addition, time off work due to mental health is an emerging trend in accepted time-loss claims by firefighters.

Cancer is a significant burden of disease for firefighters, representing over 86% of all fatality claims by firefighters in Canada. For all professions, AWCBC data reported 378 cancer fatality claims in 2015, accounting for 44.4% of all fatality claims in that year. Only 0.048% of time-loss claims in Canada were due to cancer in 2015 across all professions. [68] When looking at the age distribution of fatality claims among Canadian firefighters, cancer accounted for 40.0% of claims among firefighters aged 30-34 years, 55.6 % among ages 35-39 years, and over 80% among firefighters 40 years and older (Table 9). Among the general Canadian population, 20% of all deaths among 25 to 44 year olds, 43% of all deaths among 45 to 64 year olds, and 28% of all deaths among 65 years and older were attributable to cancer. [69]

TABLE 9: PROPORTION OF FATALITIES ATTRIBUTED TO CANCER AMONG GENERAL POPULATION AND FIREFIGHTERS, BY AGE GROUP, 2006-2015, AWCBC, STATISTICS CANADA

General Population[18]		Firefighter Population[19]		
Age Group	Proportion of Fatalities Attributed to Cancer	Age Group	Proportion of Fatalities Attributed to Cancer	Proportion of Fatalities Attributed to Cancer (average)
1-24	11%	15-19	0%	0%
		20-24	0%	
25-44	20%	25-29	0%	45.2%
		30-34	40%	
		35-39	55.6%	
		40-44	85.0%	
45-64	43%	45-49	81.1%	85.2%
		50-54	84.5%	
		55-59	85.9%	
		60-64	89.2%	
65+	28%	65+	89.8%	89.8%

The age-standardized incidence rate for all cancers among the general population in Canada was 584.3 per 100,000 population in 2010, and projected to be 548.4 per 100,000 population in 2017. [70] Age-standardized cancer incidence rates varied by province across Canada, with the highest rates for 2017 projected for Newfoundland (586.8 per 100,000), Quebec (544.9 per 100,000) and the Northwest Territories (535.2 per 100,000). The age-standardized mortality rate for all cancers among the general population in Canada was 211.0 per 100,000 population in 2011. [70] The highest rates were found in Nunavut (403.4 per 100,000 population), Yukon (286.0 per 100,000 population) and Northwest Territories (278.7 per 100,000 population) (Appendix B, Figure 1, and Figure 2). In addition, the literature review revealed that cancer is a leading cause of mortality among firefighters.

Traumatic injury was the primary cause of injury and time spent off work for firefighters. Traumatic injury accounted for 89.92% of all time-loss claims among firefighters between 2006 and 2015. For all professions, AWCBC data reported 151,415 traumatic injury time-loss claims in 2015, accounting for 65% of all time-loss claims in that year. Traumatic injury accounted for 36.3% of 2015 fatality claims in Canada across all professions. [68]

The fatality claims rate among firefighters due to cardiovascular disease (2.86 per 100,000 Canadian firefighter population) was lower than the mortality rate for ischaemic heart disease (95.2 per 100,000 population) and cerebrovascular disease (37.8 per 100,000 population) among the general Canadian population. While cardiovascular disease was revealed to be a leading cause of death among firefighters in the research literature, the claims data did not demonstrate this trend. Sudden

[18] Statistics Canada (2013) [66]
[19] AWCBC Data, 2006-2015

cardiac death was shown to be a primary cause of on-the-job mortality, however the claims data take the entire life span of firefighters into account, including causes of death from aging. In 2014, the rate of ischaemic heart disease in the general Canadian population was 95.2 per 100,000 population and the rate for cerebrovascular disease was 37.8 per 100,000 population. [71] In addition, 29% of all deaths in Canada result from heart disease. [72, 73] According to the Public Health Agency of Canada, all cardiovascular disease causes occurred at an incidence rate of 1,202.2 per 100,000 population in 2005/2006. [72]

For all professions, AWCBC data reported 143 fatality claims for systemic diseases and disorders in 2015, accounting for 16.8% of all time-loss claims in that year. Systemic disease and disorders accounted for 14,133 time-loss claims in 2015 in Canada, accounting for 6.9% of all time-loss claims that year. The mortality rate from respiratory disease in Canada is 63.1 per 100,000 population, compared to 1.43 per 100,000 Canadian firefighter population. For the general population between 2009 and 2011, there was an average of 63.1 deaths per 100,000 population from respiratory disease in Canada. [74]

Mental health challenges contribute to approximately 30% of short and long-term disability claims across all professions in Canada each year. AWCBC data showed that 1.65% of all time-loss claims among Canadian firefighters were due to mental health reasons. While this proportion appears to be below that of many other professions, provinces such as British Columbia and Alberta are reporting rates of time-loss claims of 48.0 and 33.6 per 100,000 firefighter population, respectively. Mental health factors can be attributed to an increasing number of time-loss claims among Canadian firefighters in some provinces, which may still be underreported on a national scale. This emerging trend should be taken seriously as mental health accounts for more than six billion dollars in lost productivity for employers across all professions. [75]

Previous research has suggested that lower rates than the general population for particular diseases may be a result of the healthy worker effect among firefighters. [26,32,77] The high levels of fitness and health that are mandated for all entry-level firefighters may reduce the onset of lifestyle diseases such as cancer, cardiovascular disease and respiratory disease. In addition, the health and fitness requirements would also be expected to lower the risk of death from these diseases. [77] A 2003 study found that there is no convincing evidence that employment as a firefighter is associated with increased all-cause, coronary heart disease, cancer, or respiratory disease mortality. [76] In 2015, Amadeo observed lower all-cause mortality among firefighters, relative to the general population, due to the healthy worker effect. [26] While an Australian study found a significant increase in overall risk of cancer, the risk for mortality was found to be decreased as a result of the healthy worker effect and lower smoking rates among the Australian firefighter population. [31] Firefighters may also exhibit lower rates of cancer mortality, suggesting a healthy worker survivor effect due to increased medical screening in the firefighter population. [32] These studies observed lower all-cause and leading-cause mortality among firefighters, likely due to a healthy worker effect in the firefighter population relative to the general population.

While research has shown that a healthy worker effect may exist among firefighters, AWCBC data provides evidence for increased mortality from cancer among firefighters compared to the general population and does not suggest that lifestyle factors of firefighters play a preventative role in relation to cancer mortality. The data presented in this report may support a healthy worker effect,

particularly for respiratory and cardiovascular disease. These diseases may not appear at higher rates within the firefighter population, however firefighters are known to be at a high risk for stressful situations that lead to an increased risk for traumatic injury and mental health issues.

Limitations

Firefighter populations in Canada are made up of volunteer and professional firefighters in the field. Many communities rely on volunteer firefighters to respond to emergency situations, as they do not have their own municipal fire force. The AWCBC data does not identify the status of employment of firefighters as a variable. Therefore, it is not possible to differentiate between volunteer, part-time professional and full-time professional firefighters within this dataset. Volunteer firefighters are more likely to be injured performing firefighter duties due to less training and experience. [42] However, volunteer firefighters often perform fewer hours of firefighting duties than a professional firefighter, resulting in less risk of injury over the life span. A limitation to this study is the inability to separate volunteer, part-time professional and full-time professional firefighters within the data, preventing the calculation of mortality rates by firefighter job status. Further investigation is needed to determine the difference in time-loss and fatality claims between volunteer and professional firefighters.

The population of firefighters used to calculate mortality and time-loss rates was the total population of volunteer and professional firefighters. However, as explained previously, the AWCBC data do not identify employment status of the firefighter. The assumption was made that the total population of firefighters, volunteer and professional, encompasses the total population of firefighters who would be eligible to submit a claim under their Workers' Compensation Board, regardless of employment status.

Another limitation to this study is the different methods by wich each province and territory collects and stores injury data. The national data assembled by the Association of Workers' Compensation Board of Canada were collected by each province and territory's respective Workers' Compensation Board. Once collected, the AWCBC created a national dataset. This methodology of compiling a national dataset allows room for error, as each province and territory may not record or collect information the same way. In addition, some variables are not available in certain provinces (e.g., fatality claims data in Newfoundland).

Work-related time-loss and fatality claims data were retrieved from the AWCBC, which only includes claims accepted by the governing Workers' Compensation Board. The results presented in this report may underreport the number of occupational fatalities or injuries among firefighters in Canada. A limitation of using claims data is that injuries or fatalities that were not reported to or accepted by a provincial or territorial Workers' Compensation Board are not accounted for. Therefore, results presented in this report may be under representative of the firefighter population. In addition, missing values existed within the AWCBC data due to non-reporting from some provinces. The claims data suppressed small numbers and a random assignment of values to suppressed values was performed to complete an analysis of the data. A limitation of this process is the variability of these values from the true data and unknown values, particularly among very specific variables and less populous provinces.

Injury Surveillance Systems

Occupational surveillance serves as the foundation for improving worker safety in any occupation. This paper shows that, firefighters are exposed to occupational hazards that increase their risk of injury. Occupational injury and fatality surveillance methods are essential to successfully tracking the incidence of occupational injury, analyzing trends, and determining risk for injury and death among firefighters. Surveillance data can be used to characterize and describe the magnitude and rate of a problem, identify situations that may cause high rates, and guide prevention efforts. [78]

It is difficult to get a complete and accurate picture of occupational injuries in Canada due to limitations of the available surveillance systems. Currently, there is no provincial or federal database that collects information related to all injuries or deaths that occur in the workplace. In order to analyze data related to occupational injury and death, occupational claims data is often used. Workers' compensation boards and commissions across Canada collect information about accepted time-loss injuries and fatalities. However, these data do not include all workplace injuries – only those claims that have been accepted.

The Association of Workers' Compensation Boards of Canada helps to facilitate the exchange of information and data between provincial and territorial Workers' Compensation Boards and Commissions. When an employee in Canada is injured, including firefighters, they will submit a claim to their provincial or territorial Worker's Compensation Board. For this reason, access to national statistics on occupational injury and death is only available through a compilation of accepted claims received from each province and territory. The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is Canada's principal injury surveillance program. CHIRPP collects and analyzes data as patients are admitted into the emergency rooms of 11 pediatric and 6 general hospitals in Canada. This surveillance system collects pre-event injury information but it does not include information about occupation or if the injury occurred on the job. A review of surveillance tools used to collect data on injuries in Canada is presented in Table 10. Recently, Surrey Fire Services, located in British Columbia, implemented a Health Monitoring Organization Chart into their firefighting workforce, which provides an example of a model for firefighter wellness. (Appendix C)

TABLE 10: OVERVIEW OF NATIONAL SURVEILLANCE DATA SOURCES [77]

	Fatal Injuries	Serious Injuries		Injuries Treated in Hospital Emergency Departments	Other Treated and Untreated Injuries	Injury-Related Impairments and Disabilities
		Severe Trauma	Hospitalized			
Minimum Detail Population-based Surveillance	Mortality data from Death Certificates	National Trauma Registry – Minimum Data Set		National Ambulatory Care Reporting System+		
Moderate/Expanded Detail Using Samples	National Coroner Medical Examiner Database@	National Trauma Registry – Comprehensive Data Set+		Canadian Hospitals Injury Reporting and Prevention Program		
Moderate/Expanded Detail Using Periodic Collection					Canadian Incidence Study of Reported Child Abuse and Neglect	
Moderate/Expanded Detail Focus on Specific Injury Types	National Surveillance System for Water-related Fatalities	Canadian Agricultural Injury Surveillance Program# Traffic Accident Information Database#				
Population Surveys		National population health surveys (Canadian Community Health Survey (CCHS), etc.)				Health and Activity Limitation Survey

* Adapted from Herbert M and Mackenzie SG. Model of an injury surveillance system. Health Canada. Personal correspondence.
@ Data source is under development
+ Data source developed; not yet implemented in all provinces.
# Also collect information on fatal injuries.

In the United States, four primary surveillance methods are used to collect information on injury. A 2011 study looked at four surveillance systems characterizing firefighter fatalities and informing prevention measures. [78] The Bureau of Labor Statistics' Census of Fatal Occupational Injuries (CFOI), the systems maintained by the United States Fire Administration (USFA) and the National Fire Protection Association (NFPA) were three population-based surveillance systems reviewed in this study. In addition, one case-based system, the National Institute for Occupational Safety and Health Fire Fighter Fatality Investigation and Prevention Program (FFFIPP), was analyzed. The study recommended that data from multiple surveillance systems improve the understanding of the risks to firefighters.

The CFOI data system is comprised of population-based surveillance of traumatic occupational fatalities for all occupations. However, this system does not include data on medical-related fatalities that occur on the job. The USFA data system uses population-based data on traumatic and medical on-duty firefighter fatalities. USFA receives a voluntary notification as soon as an occupational-related fatality occurs. The final population-based surveillance system, NFPA, collects data on traumatic and medical on-duty firefighter fatalities. The NFPA has restrictive inclusion criteria, in comparison to the USFA, which follows the Hometown Heroes Act, resulting in decreased reporting on heart attack and stroke cases among firefighters. Finally, the FFFIPP data system is a case-based surveillance system on firefighter fatalities, using on-site investigations of selective firefighter on-duty deaths. [79]

The World Health Organization has developed tools to collect data on injuries. The Injuries and Violence Prevention Department has collaborated with agencies across the world and collaborated to create the International Classification for External Causes of Injuries, a classification system for

injuries that adds to the existing International Classification of Diseases. This system provides guidance on how to classify and code injury data based on international standards, and set up systems for collecting, coding and processing data. The goal of this program is to provide better information about injuries and create prevention programs to reduce the incidence of death and disability due to injuries. [80]

Conclusion

The findings in this report present further evidence for the risks involved with the occupation of firefighting. Between 2006 and 2015, cancer was the leading cause of fatality claims among Canadian firefighters, while traumatic injury was the leading cause of time-loss claims among firefighters during this time period. Mental health was also a leading cause of time-loss claims in BC, Alberta and Manitoba, and represents an emerging trend towards a growing number of lost days of work among emergency responders. Future studies that continue to explore the relationship between the firefighter profession and injury should seek to improve our understanding of injury risks in the fire service by employment status.

The results of this report also provide further evidence of the need for a national firefighter injury surveillance model. Many limitations exist to using claims data to accurately assess the injury status of an entire profession. In order to accurately describe the causes of occupational injury and death among firefighters and improve injury prevention mechanisms, a surveillance model must be implemented to track each injury and fatality that occurs on the job as a firefighter.

Appendices

APPENDIX A: METHODOLOGY

The national data used to compare provinces and calculate provincial and national rates was received from the AWCBC. The method of random allocation was performed on suppressed values to form a complete data set without missing values. Throughout the analysis, total values were calculated by aggregating values in each year, including suppressed values. Rates calculated from these totals did not differ significantly than if the true totals were used to calculate rates, as seen in Table 1. While the data set includes data from 2006 to 2015, some provinces did not report data from all years within this time frame. Table 2 outlines the years that each province reported on for time-loss and fatality claims.

TABLE 1: CALCULATION OF FATALITY AND TIME-LOSS CLAIMS METHODOLOGY

Nature of Injury	Rate per 100,000 firefighter population determined through random allocation of suppressed values		Rate per 100,000 firefighter population determined through true totals	
	Fatality claims	*Time-loss claims*	*Fatality claims*	*Time-loss claims*
Traumatic Injuries	4.39	1566.15	3.77	1307.28
Nervous system and sense organs diseases	0.20	13.10	0.51	13.10
Circulatory system diseases	2.86	6.50	2.86	6.69
Respiratory system diseases	1.43	3.02	1.02	3.21
Digestive system diseases and disorders	0.00	15.08	0.00	15.08
Genitourinary system diseases and disorders	0.00	0.57	0.00	0.28
Musculoskeletal system and connective tissue diseases and disorders	0.00	33.66	0.00	33.66
Disorders of the skin and subcutaneous tissue	0.00	4.62	0.00	4.53
Infectious, bacterial, viral, parasitic diseases	0.10	5.28	0.20	4.71
Cancer	49.97	23.47	49.87	21.31
Mental disorders or syndromes	0.20	23.95	0.20	23.95
Other	0.00	12.44	0.00	11.97
Unknown	0.61	8.86	0.31	8.11

TABLE 2: REPORTED NUMBER OF YEARS BY PROVINCE FOR NATURE OF INJURY VARIABLE, AWCBC

Province	Fatality Claims	Time-loss Claims
Alberta	2006-2015	2006-2015
British Columbia	2006-2015	2006-2015
Manitoba	2006-2015	2006-2015
New Brunswick	2009, 2010, 2012-2015	2006-2015

Newfoundland	No data	2006-2015
Nova Scotia	2008, 2012-2015	2006-2015
Northwest Territories/ Nunavut	No data	2006-2015
Ontario	2006-2015	2006-2015
Prince Edward Island	No data	2006-2011, 2013-2015
Quebec	2006-2012, 2014, 2015	2006-2015
Saskatchewan	2006-2008, 2010-2015	2006-2015
Yukon	2012	2006-2009, 2011-2015

TABLE 3: DATA ANALYSIS GROUPING BASED ON AWCBC CODING FOR NATURE OF INJURY

Analysis Grouping	AWCBC Coding
Cancer	30- Neoplasms, tumors, and cancer, unspecified 31- Malignant neoplasms and tumors (cancers, carcinomas, sarcomas) 32- Benign neoplasms and tumors 33- Neoplasms and tumors of unknown properties 39- Neoplasms, tumors, and cancer, not elsewhere classified (n.e.c.)
Cardiovascular system diseases	13- Circulatory system diseases
Digestive system diseases	15- Digestive system diseases and disorders
Genitourinary system diseases	16- Genitourinary system diseases and disorders
Infectious, bacterial, viral, parasitic diseases	20- Infectious and parasitic diseases, unspecified 21- Bacterial diseases 22- Viral diseases 23- Other arthropod-borne diseases 26- Infectious diseases peculiar to the intestines 29- Other infectious and parasitic diseases
Mental health	52- Mental disorders or syndromes
Musculoskeletal system and connective tissue disease	17- Musculoskeletal system and connective tissue diseases and disorders
Nervous system diseases	12- Nervous system and sense organs diseases
Other	41- Symptoms 49- Other symptoms, signs and ill-defined conditions, n.e.c. 59- Other diseases, conditions and disorders, n.e.c. 80- Multiple diseases, conditions, and disorders NC- Not coded
Respiratory system diseases	14- Respiratory system diseases
Skin and subcutaneous tissue diseases	18- Disorders of the skin and subcutaneous tissue
Traumatic injuries	00- Traumatic injuries and disorders, unspecified 01- Traumatic injuries to bones, nerves, spinal cord 02- Traumatic injuries to muscles, tendons, ligaments, joints, etc. 03- Open wounds 04- Surface wounds and bruises 05- Burns 06- Intracranial injuries 07- Effects of environmental conditions 08- Multiple traumatic injuries and disorders 09- Other traumatic injuries and disorders

Analysis Grouping	AWCBC Coding
Unknown	99- Unknown

TABLE 4: DATA ANALYSIS GROUPING BASED ON WORKSAFEBC CODING FOR NATURE OF INJURY

Analysis Grouping	WorkSafe BC Coding
Traumatic Injuries and Disorders	0000- Traumatic Injuries & Disorders, uns. 0100- Traumatic Injury-Bones, Nerves, Spinal cord, uns. 01100- Dislocations 01200- Fractures 01300- Traumatic Injury to Spinal cord 01400- Traumatic Injury-Nerves, except Spinal cord 01800- Multiple Traumatic Injury-Bones, Nerves, Spinal cord 01900- Traumatic Injury-Bones, Nerves, Spinal cord, n.e.c. 02000- Traumatic Injury to Muscles, Joints, etc. uns. 02100- Sprains, Strains, Tears 02101- Rotatorcuff Tear, Traumatic 02190- Sprains, Strains, Tears, n.e.c. 02190- Injury to Muscles, Tendons, Joints, etc, n.e.c. 02901- Traumatic Bursitis 02902- Traumatic Tendonitis 02903- Traumatic Epidondylitis 02904- Traumatic Capsulitis 02905- Traumatic Ganglion 02906- Traumatic Synovitis 02907- Traumatic Tenosynovitis 02908- Traumatic Myositis 02909- Traumatic Injury to Muscles, Joints, n.e.c. 03000- Open Wounds 03100- Amputation, uns. 03110- Amputation, Fingertip 03190- Amputations, n.e.c. 03200- Animal or Insect Bites 03300- Avulsions 03400- Cuts, Lacerations 03500- Enucleations 03600- Gunshot wounds 03700- Punctures, except Bites 03800- Multiple open Wounds 03900- Open Wounds, n.e.c. 04000- Surface Wounds and Bruises, uns. 04100- Abrasions, Scratches 04200- Blisters 04300- Bruises, Contusions 04400- Foreign Bodies-Superficial Splinters, Chips 04500- Friction Burns 04800- Multiple Surface Wounds And Bruises 04900- Surface Wounds And Bruises, n.e.c. 05000- Burns, uns. 05100- Chemical Burns, uns. 05101- First-Degree Chemical Burns 05102- Second-Degree Chemical Burns 05103- Third-Degree Chemical Burns 05190- Chemical Burns, n.e.c. 05200- Electrical Burns, uns. 05201- First-Degree Electrical Burns

Analysis Grouping	WorkSafe BC Coding
	05202- Second-Degree Electrical Burns 05203- Third-Degree Electrical Burns 05290- Electrical Burns, n.e.c. 05300- Heat Burns, Scalds, uns. 05301- First-Degree Heat Burns, Scalds 05302- Second-Degree Heat Burns, Scalds 05303- Third-Degree Heat Burns, Scalds 05390- Heat Burns, Scalds, n.e.c. 05800- Multiple Burns 05900- Burns, n.e.c. 06000- Intracranial Injuries, uns. 06100- Cerebral Hemorrhages 06200- Concussions 06800- Multiple Intracranial Injuries 06900- Intracranial Injuries, n.e.c. 07000- Effects of Environmental Conditions, uns. 07100- Effects of Reduced Temperature, uns. 07110- Frostbite 07120- Hypothermia 07130- Trench Foot 07180- Multiple Effects of Reduced Temperature 07190- Effects of Reduced Temperature, n.e.c. 07200- Effects of Heat and Light, uns. 07210- Heat Stroke 07220- Heat Syncope 07230- Heat Fatigue 07240- Heat Edema 07280- Multiple Effects of Heat and Light 07290- Effects of Heat and Light, n.e.c. 07300- Effects of Air Pressure, uns. 07310- Aero-Otitis Media 07320- Aerosinusitis 07330- Caisson Disease, Bends, Divers Palsy 07380- Multiple Effects of Air Pressure 07390- Effects of Air Pressure, n.e.c. 07800- Multiple Effects of Environmental Conditions 07900- Effects of Environmental Conditions, n.e.c. 08000- Multiple Traumatic Injuries, Disorders, uns. 08100- Cuts, Abrasions, Bruises 08200- Sprains and Bruises 08300- Fractures and Burns 08400- Fractures and other Injuries 08500- Burns And other Injuries 08600- Intracranial and Internal Organ Injury 08900- Other Combi-Traumatic Injury, Disorder, n.e.c. 08901- Multiple Traumatic Injury, Disorder with Fracture 08902- Multiple Traumatic Injury, Disorder no Fracture 09000- Other Traumatic Injuries, Disorders, uns. 09100- Asphyxiation, Strangulation, Suffocation 09200- Drownings 09300- Electrocutions, Electric Shocks 09400- Internal Injury to Trunk, Blood Vessels, Organs 09500- Other Poisonings, Toxic Effects, uns. 09510- Animal or Insect Bites, Venomous

Analysis Grouping	WorkSafe BC Coding
	09520- Radiation Sickness 09590- Other Poisonings, Toxic Effects, n.e.c. 09600- Traumatic Complications, uns. 09610- Traumatic Shock 09620- Embolism, Air or Fat 09680- Multiple Traumatic Complications 09690- Traumatic Complications, n.e.c. 09700- Nonspecific Injuries & Disorders, uns. 09710- Crushing Injuries 09720- Back Pain, Hurt Back 09730- Soreness, Pain, Hurt, Except the Back 09780- Multiple Nonspecific Injuries & Disorders 09790- Nonspecific Injuries, Disorders, n.e.c. 09900- Other Traumatic Injuries, Disorders, n.e.c.
Other systemic diseases and disorders	10000- Systemic Diseases and Disorders, uns. 11000- Disease Of Blood & Blood-forming Organs, uns. 11100- Hemolytic Anemia--Non-Autoimmune 11200- Aplastic Anemia 11300- Agranulocytosis or Neutropenia 11400- Methemoglobinemia 11500- Purpura, Other Hemorrhagic Conditions 11900- Disease of Blood & Blood-forming Organs, n.e.c. 19000- Other Systemic Diseases & Disorders, uns. 19100- Endocrine, Metabolic, Immunity Disorder, uns. 19110- Diseases and Disorders of Thyroid Gland 19120- Diseases, Disorders-Other Endocrine Glands 19190- Endocrine, Nutritional, Immunity Disorder, n.e.c. 19900- Systemic Diseases & Disorders, n.e.c. 19901- Scleroderma
Nervous system and sense organs diseases	12000- Nervous System, Sense Organs Diseases, uns. 12100- Inflammatry Disease, Central Nervous system, uns. 12110- Encephalitis 12120- Meningitis 12190- Inflammatry Disease, Central Nervous system, n.e.c. 12200- Degenerative Disease, Central Nervous system, uns. 12210- Cerebellar Ataxia 12220- Reye's Syndrome 12290- Degenerative Disease, Central Nervous system, n.e.c. 12300- Other Disorder, Central Nervous System, uns. 12310- Anoxic Brain Damage 12320- Migraine 12390- Other Disorder, Central Nervous System, n.e.c. 12400- Disorders, Peripheral Nervous System, uns. 12410- Carpal Tunnel Syndrome 12420- Inflammatory & Toxic Neuropathy, Polyneuropathy 12430- Toxic Myoneural Disorders 12490- Other Disorder, Peripheral Nervous System, n.e.c. 12491- Bells Palsy 12500- Disorders Of The Eye, Adnexa, Vision, uns. 12510- Solar Retinopathy 12520- Conjunctivitis--Non-Viral 12521- Eye Ulcer, Corneal Erosion 12530- Inflammation Except Conjunctivitis 12540- Cataract

Analysis Grouping	WorkSafe BC Coding
	12550- Blindness, Low Vision 12560- Welder's Flash 12570- Glaucoma 12580- Visual Disturbances 12590- Disorders Of The Eye, Adnexa, Vision, n.e.c. 12600- Disorders: Ear, Mastoid Process, Hearing, uns. 12610- Deafness, Hearing Loss Or Impairment 12620- Tinnitis 12630- Otalgia 12640- Mastoiditis 12650- Otitis Media (Except Aero-) 12690- Disorder: Ear, Mastoid Process, Hearing, n.e.c. 12900- Nervous System, Sense Organs Disease, n.e.c.
Circulatory system diseases	13000- Circulatory System Diseases, uns. 13100- Rheumatic Fever with Heart Involvement 13200- Hypertensive Disease 13300- Ischemic Heart Disease, uns. 13310- Myocardial Infarction (Heart Attack) 13320- Angina 13390- Ischemic Heart Disease, n.e.c. 13400- Diseases of Pulmonary Circulation, uns. 13410- Pulmonary Heart Disease 13490- Diseases of Pulmonary Circulation, n.e.c 13500- Other Forms of Heart Disease, uns. 13510- Toxic Myocarditis 13520- Heart Failure 13530- Ill-Defined & Complication of Heart Disease 13590- Other Forms of Heart Disease, n.e.c. 13600- Cerebrovascular Disease, uns. 13610- Stroke 13620- Transient Ischemic Attacks 13690- Cerebrovascular Disease, n.e.c. 13700- Disease-Artery, Arteriole, Capillary, uns. 13710- Raynauds Syndrome, Phenomenon: White Finger 13720- Aneurysm--Nontraumatic 13790- Disease- Artery, Arteriole, Capillary, n.e.c 13800- Diseases Of The Veins, Lymphatics, uns. 13810- Varicose Veins 13820- Hemorrhoids 13830- Phlebitis 13890- Diseases of the Veins, Lymphatics, n.e.c 13900- Circulatory System Diseases, n.e.c. 13901- Telangiectasis (Aluminum Workers)
Respiratory system diseases	14000- Respiratory System Diseases, uns. 14100- Acute Respiratory Infection, Including Common Cold 14200- Other Disease, Upper Respiratory Tract, uns. 14210- Allergic Rhinitis 14220- Chronic Condition, Upper Respiratory Tract 14290- Other Disease, Upper Respiratory Tract, n.e.c. 14300- Pneumonia, Influenza, uns. 14310- Pneumonia 14320- Influenza 14330- Legionnaires Disease 14340- Severe Acute Respiratory Syndrome (SARS)

Analysis Grouping	WorkSafe BC Coding
	14390- Pneumonia, Influenza, n.e.c. 14400- Chronic Obstructive Pulmonary Disease, uns. 14410- Bronchitis 14420- Emphysema 14430- Extrinsic Asthma 14440- Extrinsic Allergic Alveolitis, Pneumonitis 14490- Chronic Obstructive Pulmonary Disease, n.e.c. 14491- Chronic Obstructive Lung Disease(C.O.L.D.) 14500- Pneumoconioses, uns. 14510- Coal Workers' Pneumoconiosis 14520- Asbestosis 14530- Silicosis 14540- Talcosis 14550- Aluminosis 14560- Berylliosis 14570- Siderosis 14580- Pneumoconiosis with Tuberculosis 14590- Pneumoconioses, n.e.c. 14600- Pneumonopathy, uns. 14610- Byssinosis, Mill Fever 14620- Metal Fume Fever 14690- Pneumonopathy, n.e.c. 14900- Other Respiratory Diseases, uns. 14910- Humidifier Fever 14920- Pneumonitis, n.e.c. 14930- Pulmonary Edema 14940- Pulmonary Fibrosis, n.e.c. 14950- Atelectasis, Collapsed Lung 14990- Other Respiratory System Diseases, n.e.c 14991- Reactive Airway Dysfunction Syndrome (R.A.D.S.)
Digestive and Genitourinary system diseases and disorders	15000- Digestive System Diseases, Disorders, uns. 15100- Disease: Oral Cavity, Salivary Glands, Jaws 15200- Diseases of Esophagus, Stomach, Duodenum 15300- Hernia, uns. 15310- Inguinal Hernia 15320- Hiatal Hernia 15330- Ventral Hernia 15390- Hernia, n.e.c. 15400- Noninfectious Enteritis & Colitis 15500- Other Diseases of Intestines, Peritoneum 15600- Toxic Hepatitis--Noninfective 15900- Digestive System Disease, Disorder, n.e.c, 16000- Genitourinary System Disease, Disorder, uns. 16100- Nephritis, Nephrotic Syndrome, Nephrosis, uns. 16110- Nephritis 16120- Nephrotic Syndrome 16130- Nephrosis 16190- Nephritis/Nephrotic Syndrome & Nephrosis, n.e.c. 16200- Other Diseases of Urinary System, uns. 16210- Cystitis 16230- Renal Failure 16290- Other Diseases of Urinary System, n.e.c. 16300- Diseases and Disorders-Genital Tract,uns. 16310- Infertility

Analysis Grouping	WorkSafe BC Coding
	16320- Spontaneous Abortion, Miscarriage 16390- Diseases, Disorders-Genital Tract, n.e.c. 16400- Disorders of Breast 16900- Genitourinary System Disease, Disorder, n.e.c.
Musculoskeletal system and connective tissue disease and disorders	17000- Muskuloskelsys, Connect. Tissue Disease, uns. 17100- Arthropathies, Reltd Disorders(Arthritis) 17200- Dorsopathies, uns. 17201- Dorsalgia 17202- Cervicalgia 17210- Sciatica 17220- Lumbago 17230- Disc Disorders 17231- Disloctd, Herniatd, Slippd, Rupturd Disc 17232- Intervertebral Disc Syndrome 17233- Diskarthrosis 17239- Disc Disorders, n.e.c. 17290- Dorsopathies, n.e.c. 17291- Minor Intervertebral Disorders (Mid) 17292- Facett Syndrome 17293- Radiculitis 17300- Inflam. Irritatn Of Joint/Muscle Etc uns. 17310- Bursitis (For Traumatic Use Code 02901) 17320- Synovitis 17330- Tendinitis (For Traumatic Use 02902) 17340- Tenosynovitis 17350- Ganglion/Cystic Tumor 17360- Myositis 17390- Other Inflam/Irrtn of Joint/Muscle/Tendn 17391- Rotator Cuff Syndrome 17392- Duprytren S Contracture 17393- Epicondylitis 17394- Capsulitis 17395- Trigger Finger(Excludes Traumatic 02909) 17400- Osteopthy, Chondropt, Acquird Deformts, uns. 17410- Curvature of Spine 17490- Osteopthy, Chondropt, Acquird Deform, n.e.c. 17900- Muskuloskelsys, Connect Tissue Dis, n.e.c. 17901- Fibromyalgia, Fibrositis, Myofasciitis
Disorders of the skin and subcutaneous tissue	18000- Disorders: Skin, Subcutaneous Tissue, uns. 18100- Infections: Skin, Subcutaneous Tissue, uns. 18110- Carbuncle and Furuncle 18120- Cellulitis and Abscess 18130- Acute Lymphadenitis 18140- Impetigo 18150- Pilonidal Cyst 18160- Pyoderma 18190- Infection: Skin, Subcutaneous Tissue, n.e.c. 18200- Dermatitis, uns. 18210- Atopic Dermatitis and Related Conditions 18220- Contact Dermatitis and Other Eczema 18230- Allergic Dermatitis 18240- Irritant Dermatitis 18250- Other Contact Dermatitis 18260- Dermat Due to Substance Taken Internally

Analysis Grouping	WorkSafe BC Coding
	18290- Dermatitis, n.e.c. 18300- Other Inflammatory Condition of Skin, uns. 18310- Erythematosquamous Dermatosis 18320- Bullous Dermatoses 18330- Rosacea 18340- Other Erythematous Conditions 18350- Psoriasis and Similar Disorders 18360- Lichen 18370- Pruritus and Related Conditions 18390- Other Inflammatory Conditions, n.e.c. 18400- Diseases of Sebaceous Glands, uns. 18410- Acne 18420- Sebaceous Cyst 18490- Diseases of Sebaceous Glands, n.e.c. 18900- Other Diseases, Disorders-Skin, Subcut. Tissue, uns. 18910- Corns, Callosities (Incl Callus, Clavus) 18920- Other Hypertrophic, Atrophic Conditions 18930- Diseases of Nail (Incl Ingrowing Nail) 18940- Diseases of Hair and Hair Follicles 18950- Disorder: Sweat Glands(Incl Prickly Heat) 18960- Vitiligo 18970- Chronic Skin Ulcers 18980- Urticaria, Hives 18990- Other Diseases, Diso: Skin, Subcut. Tissue, n.e.c.
Infectious and parasitic diseases	20000- Infectious & Parasitic Diseases, uns. 21000- Bacterial Diseases, uns. 21100- Tuberculoses, uns. 21110- Primary Tuberculous Infection 21120- Pulmonary Tuberculosis 21130- Miliary Tuberculosis 21190- Tuberculoses, n.e.c. 21200- Zoonotic Bacterial Diseases, uns. 21210- Plague 21220- Tularemia 21230- Anthrax 21240- Brucellosis 21250- Glanders 21260- Melioidosis 21270- Rat-Bite Fever 21290- Zoonotic Bacterial Diseases, n.e.c.. 21300- Syphilis and Other Venereal Diseases, uns. 21310- Early Syphilis 21320- Cardiovascular Syphilis 21330- Neurosyphilis 21340- Gonorrhea and Other Gonococcal Infections 21390- Syphilis & Other Venereal Diseases, n.e.c.. 21400- Other Spirochetal Diseases, uns. 21410- Leptospirosis 21420- Vincent's Angina 21430- Yaws 21440- Pinta 21490- Other Spirochetal Diseases, n.e.c.. 21900- Other Bacterial Diseases, uns. 21910- Leprosy

Analysis Grouping	WorkSafe BC Coding
	21920- Diphtheria, Whooping Cough 21930- Streptococcal Sore Throat And Scarlatina 21940- Erysipelas 21950- Meningococcal Infection 21960- Tetanus 21970- Septicemia 21980- Actinomycotic Infections 21990- Other Bacterial Diseases, n.e.c. 21991- Necrotizing Fasciitis 22000- Viral Diseases, uns. 22100- Human Immunodeficiency Virus(Hiv) Infection, uns. 22110- Acquired Immune Deficiency Syndrome(Aids) 22120- Aids-Like Syndrome, Aids-Related Complex(Arc) 22190- HIV Infection, n.e.c. 22191- Contact: Bioliquid(Body Fluid)Contamd(HIV) 22192- Contact: HIV Caused By Aggression 22193- Asymptmtc HIV + Not Otherwise Specified, Unconfirmed 22200- Non-Arthrpd-Borne Viraldis. Cnervsyst, uns. 22210- Acute Poliomyelitis 22220- Slow Virus Infection-Centrl Nerv.System 22230- Meningitis Due To Enterovirus 22240- Other Enterovirus Diseases 22290- Non-Arthrpd-Borne Viraldis. C Nervsys, n.e.c. 22300- Viral Diseas Accompanied By Exanthem, uns. 22310- Smallpox 22320- Cowpox And Paravaccinia 22330- Chickenpox 22340- Herpes Zoster 22350- Herpes Simplex 22360- Measles 22370- Rubella/German Measles 22390- Viral Disease Accompanied by Exanthem, n.e.c. 22400- Arthropod-Borne Viral Diseases, uns. 22410- Yellow Fever 22420- Dengue 22430- Viral Encephalitis 22440- Hemorrhagic Fever 22450- West Nile Viral Disease 22490- Arthropod-Borne Viral Diseases, n.e.c. 22500- Viral Hepatitis, uns. 22510- Type A Viral Hepatitis(Infectious Hepat) 22520- Type B Viral Hepatitis (Serum Hepatitis) 22530- Hepatitis C 22590- Non Type A or Type B Viral Hepatitis 22600- Viral Diseases of the Conjunctiva, uns. 22610- Trachoma 22620- Viral Conjunctivitis (Ophthalmia) 22690- Viral Diseases of the Conjunctiva, n.e.c 22900- Other Disease due to Viruses, Chlamydiae, uns. 22910- Rabies 22920- Mumps 22930- Ornithosis, Including Parrot Fever, Psittacosis 22940- Specific Diseases due to Coxsackie Virus 22950- Infectious Mononucleosis

Analysis Grouping	WorkSafe BC Coding
	22960- Cat Scratch Disease 22970- Foot and Mouth Disease 22990- Other Disease due to Virus, Chlamydiae, n.e.c 22991- Wart 23000- Other Arthropod-Borne Diseases 23100- Rickettsioses Diseases, uns. 23110- Spotted Fevers 23120- Q Fever 23130- Tick Typhus 23140- Trench Fever 23190- Rickettsioses Diseases, n.e.c. 23200- Typhus 23300- Malaria 23400- Leishmaniasis 23500- Trypanosomiasis (Including Chagas Disease) 23600- Relapsing Fever 23700- Lyme Disease 23900- Other Arthropod-Borne Diseases, n.e.c. 24000- Mycoses, uns. 24100- Dermatophytosis (Including Athletes Foot, Tinea) 24200- Dermatomycosis 24300- Candidiasis 24400- Coccidioidomycosis 24500- Histoplasmosis 24600- Blastomycotic Infection 24900- Mycoses, n.e.c. 25000- Helminthiases, uns. 25100- Schistosomiasis (Including Bilharziasis) 25200- Other Trematode Infection (Including Fluke) 25300- Echinococcosis 25400- Other Cestode Infection (Including Tapeworm) 25500- Trichinosis 25600- Filarial Infection and Dracontiasis 25700- Ancylostomiasis and Necatoriasis 25800- Unspecified Intestinal Parasitism 25900- Helminthiases, n.e.c. 26000- Infects Disease Peculiar to Intestine, uns. 26100- Cholera 26200- Typhoid and Paratyphoid Fevers 26300- Other Salmonella Infections 26400- Shigellosis 26500- Other Bacterial Food Poisoning 26600- Amebiasis 26700- Colitis 26800- Dysentery 26900- Infects Disease Peculiar To Intestine, n.e.c. 29000- Other Infectious, Parasitic Diseases, uns. 29100- Toxoplasmosis 29200- Trichomoniasis 29300- Pediculosis, Phthirus Infestation (Lice) 29400- Acariasis (Including Scabies, Chiggers, Mites) 29500- Other Infestation Including Maggots, Jigger Disease 29600- Sarcoidosis 29900- Other Infectious, Parasitic Diseases, n.e.c.

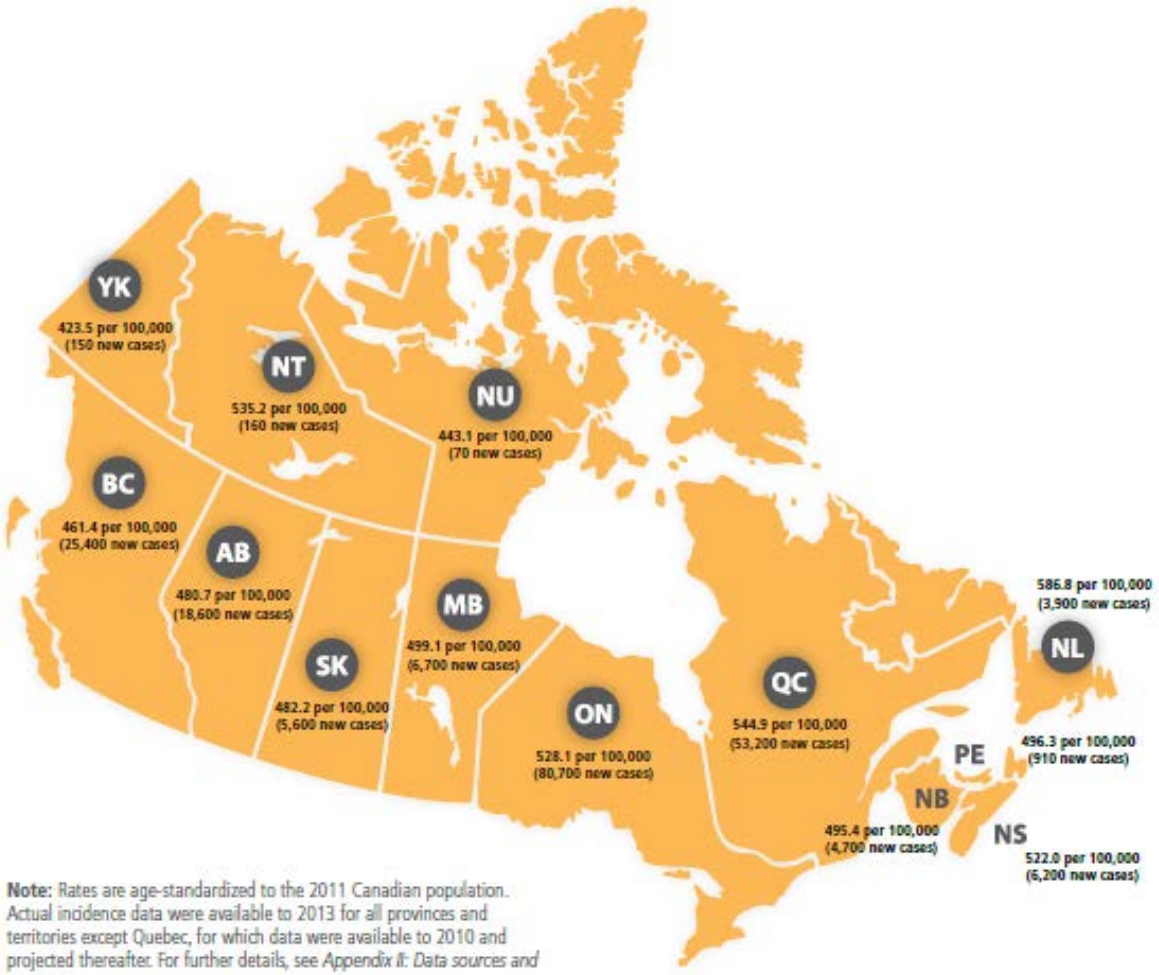
Analysis Grouping	WorkSafe BC Coding
Neoplasms, tumors, and cancer	30000- Neoplasms, Tumors, and Cancer 31000- Malignant Neoplasms, Tumors (Cancers), uns. 31100- Malignant Neoplasms, Tumor-Bone/Connective Tissue, uns. 31110- Bone, Articular Cartilage 31120- Connective and Other Soft Tissue 31180- Multiple Malignant Neoplasms, Tumor-Bone/Connective Tissue 31190- Malignant Neoplasms & Tumors Of Bone, n.e.c. 31200- Malignant Neoplasms,Tumors of Skin, uns. 31210- Melanoma of the Skin (Melanocarcinoma) 31220- Nonmelanoma Skincancer (Squams, Basalcell) 31280- Multiple Malignant Neoplasms, Tumors of Skin 31290- Malignant Neoplasms & Tumors of Skin, n.e.c. 31300- Malignant Neoplasms, Tumor: Lymphatic, Hemat. Tissue, uns. 31310- Lymphosarcoma, Reticulosarcoma (Lymphoma) 31320- Hodgkin's Disease 31330- Multiple Myeloma 31340- Leukemias 31380- Multiple Malignant. Neoplasms, Tumor- Lympht, Hemato. Tissue 31390- Malignant Neoplasms,Tumor: Lymphtc, Hemato. Tissue, n.e.c. 31900- Malignant Neoplasms, Tumors of other Sites 31901- Mesothelioma 32000- Benign Neoplasms & Tumors, uns. 32100- Benign Neoplasms- Bone, Connective Tissue, Skin, uns. 32110- Benign Neoplasm-Bone, Articular Cartilage 32120- Lipoma (Fatty Tumor) 32130- Benign Neoplasms of the Skin 32140- Other Benign Neoplasms: Connective, Other Soft Tissue 32180- Multi Benign Neoplasms: Bone, Connective Tissue, Skin 32190- Benign Neoplasms of Bone & Skin, n.e.c. 32900- Benign Neoplasms, Tumor of other Sites, uns. 32910- Hemangioma and Lymphangioma: Any Site 32980- Multiple Benign Neoplasms, Tumors: Other Sites 32990- Benign Neoplasms, Tumor of Other Sites, n.e.c. 33000- Neoplasm, Tumor of Unknown Properties, uns. 33100- Bone, Artculr Cartlage Neoplasms, Tumor-Unknown Pro 33200- Connective Other Soft Tissue Neoplasms, Tumor-Unk.Pro 33300- Skin Neoplasms, Tumors- Unknown Properties 33800- Multiple Neoplasm,Tumor of Unknown Properties 33900- Neoplasm, Tumor: Other Sites, Unknown Pro, n.e.c. 39900- Neoplasms, Tumors & Cancer, n.e.c.
Mental disorders or syndromes	52000- Mental Disorder or Syndrome, uns. 52100- Anxiety, Stress, Neurotic Disorders, uns. 52110- Post-Traumatic Stress 52130- Panic Disorder 52190- Other Anxiety, Stress, Neurotic Disorders 52191- Depressive State 52192- Burn Out 52193- Adjustment Disorders 52194- Psychological Decompensation 52200- Organc Mental Disorder- Neurotc, Psychtc, uns. 52210- Substance-Induced Mental Disorder 52220- Organic Affective Syndrome 52280- Multiple Organic Mental disorder- Neurotic, Psychotic 52290- Organic Mental Disorder- Neurotic, Psychotic, n.e.c.

Analysis Grouping	WorkSafe BC Coding
	52900- Mental Disorders or Syndromes, n.e.c. 70002- Post-Traumatic Stress S5.1 Mental Stress
Symptoms, signs, and ill-defined conditions	40000- Symptoms, Signs, Ill-Def. Conditions, uns. 41000- Symptoms, uns. 41100- General Symptoms, uns. 41110- Loss of Consciousness--Not Heat Related 41120- Convulsions, Seizures 41130- Malaise and Fatigue 41140- Dizziness 41150- Non-Specified Allergic Reaction 41151- Sick Building Syndrome 41180- Multiple General Symptoms 41190- General Symptoms, n.e.c. 41200- Symptom Involving Nerves, Musculoskel System, uns. 41210- Spasms or Tremors, n.e.c. 41220- Earache 41230- Eye Strain 41280- Multiple Symptom Involving Nerves, Musculoskelsys 41290- Symptom Involving Nerves, Musculoskel System, n.e.c. 41300- Symptom Involving Skin, Other Integumntry Tissue, uns. 41310- Edema (Including Dropsy) 41320- Cyanosis 41330- Pallor and Flushing 41380- Multiple Symptom. Involving Skin, Other Integum. Tissue 41390- Symptom Involving Skin, Other Integum. Tissue., n.e.c 41400- Symptoms Involving Head and Neck, uns. 41410- Headache, Except Migraine 41420- Loss of Voice, Voice Disturbances 41480- Multiple Symptoms Involving Head, Neck 41490- Symptoms Involving Head and Neck, n.e.c. 41500- Symptom Involving Cardiovascular System, uns. 41510- Unspecified Tachycardia (Rapid Heart Beat) 41520- Gangrene 41530- Enlargement of Lymph Nodes 41580- Multiple Symptoms Involving Cardiovascular System 41590- Symptom Involving Cardiovascular System, n.e.c. 41600- Symptom Involving Respiratory System, Chest, uns. 41610- Hyperventilation 41620- Hemoptysis (Cough With Hemorrhage) 41630- Abnormal Sputum 41640- Chest Pain 41680- Multiple Symptom Involving Respiratory System, Chest 41690- Symptom Involving Respiratory System, Chest, n.e.c 41700- Symptom Involving Digestive, Urinary System, uns. 41710- Nausea and Vomiting 41720- Heartburn 41730- Frequency of Urination and Polyuria 41740- Oliguria and Anuria 41750- Abdominal Pain, uns. 41780- Multiple Symptom Involving Digestive, Urinary System 41790- Symptom Involving Digestive, Urinary System, n.e.c. 41800- Multiple Symptoms 41801- Motion Sickness 41900- Other Symptoms, n.e.c.

Analysis Grouping	WorkSafe BC Coding
	42000- Abnormal Findings, uns. 42100- Abnormal Findings from Exam of Blood, uns. 42110- Abnormal Blood Level of Lead 42120- Abnormal Blood Level of Substances, Except Lead 42190- Abnormal Findings from Blood Exam, n.e.c. 42200- Abnormal Findings from Exam of Urine 42300- Abnormal Findings from other Body Substances 42400- Abnormal Findings Radiolgcl other Exam, Bodystructure 42500- Abnormal Findings from Function Studies 42600- Abnormal Findings from Histolgcl, Immunolgcl Stud 42700- Multiple Abnormal Findings 42900- Other Abnormal Findings 48000- Multiple Symptoms, Sign, Ill-Defined Conditions, uns. 48100- Multiple Chemical Sensitivity 48900- Multiple Symptoms, Sign, Ill-Defined. Conditions, n.e.c 49000- Symptom, Sign, Ill-Defined Condition, n.e.c. 49001- Contact with or Carriers of Tuberculosis 49002- Contact with or Carriers of Poliomyolits 49003- Contact with or Carriers of Rabies 49009- Contact with or Carrier: Infctv Parasitic Disease 49100- Contacts with or Carriers of Disease, uns. 49101- Contact with or Carriers of Tuberculosis 49102- Contacts with Carriers of Poliomyelitis 49103- Contacts with or Carriers of Rabies 49104- Contacts with or Carriers of SARS 49109- Contact/Carriers Of Infectv Parasitc Disease 49190- Contacts with or Carriers of Disease, n.e.c. 50000- Other Diseases, Conditions, Disorders 51000- Damage to or Loss of Prosthetic Devices 59000- Other Disease, Conditions, Disorders, n.e.c. 70001- Chronic Pain 80000- Multiple Diseases, Conditions, Disorders 99990- Unknown 2919- *unknown* 2102- *unknown* 2911- *unknown* 17370- *unknown* 2914- *unknown* 2917- *unknown*

APPENDIX B: ADDITIONAL FIGURES

FIGURE 1: GEOGRAPHIC DISTRIBUTION OF PROJECTED NEW CANCER CASES AND AGE-STANDARDIZED INCIDENCE RATES (ASIR) BY PROVINCE AND TERRITORY, 2017



Note: Rates are age-standardized to the 2011 Canadian population. Actual incidence data were available to 2013 for all provinces and territories except Quebec, for which data were available to 2010 and projected thereafter. For further details, see *Appendix II: Data sources and methods.*

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

FIGURE 2: GEOGRAPHIC DISTRIBUTION OF PROJECTED DEATHS AND AGE-STANDARDIZED MORTALITY RATES (ASIR) BY PROVINCE AND TERRITORY, 2017

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

Note: Rates are age-standardized to the 2011 Canadian population.

FIGURE 3: RESULTS FROM THE 2007 STUDY BY BATES [39]

TABLE III. Comparison of Results for 1988–1995 and 1996–2003 in Subjects Aged 21–60

		1988–1995			1996–2003		
Cancer site	**SEER codes[a]**	**No.[b]**	**OR[c]**	**95% CI**	**No.[b]**	**OR[c]**	**95% CI**
Esophagus	21010	8	1.36	0.67–2.78	15	1.86	1.10–3.14
Stomach	21020	13	1.31	0.75–2.99	7	0.64	0.30–1.36
Cecum	21041	6	1.07	0.48–2.43	8	1.16	0.58–2.36
Colo-rectal	21043–8	48	1.14	0.83–1.56	62	1.18	0.89–1.55
Pancreas	21100	11	1.16	0.63–2.13	9	0.74	0.38–1.45
Lung & bronchus	22030	62	0.85	0.64–1.14	47	0.77	0.56–1.05
Melanoma–skin	25010	74	1.55	1.19–2.01	128	1.86	1.51–2.29
Prostate	28010	89	1.46	1.12–1.91	214	1.55	1.28–1.88
Testis	28020	37	1.92	1.32–2.80	32	1.29	0.87–1.92
Bladder	29010	18	0.71	0.44–1.14	27	0.94	0.63–1.40
Kidney & renal pelvis	29020	24	1.47	0.96–2.24	22	0.87	0.57–1.35
Brain	31010	22	1.63	1.05–2.52	19	1.08	0.68–1.72
Thyroid	32010	12	1.54	0.86–2.76	14	1.15	0.67–1.98
Non-Hodgkin's lymphoma	33041–2	42	1.03	0.74–1.43	38	0.94	0.67–1.32
Multiple myeloma	34000	9	1.85	0.95–3.61	10	1.41	0.75–2.65
Leukemias	35011–43	18	1.18	0.73–1.90	19	1.06	0.67–1.69

[a]Surveillance Epidemiology and End Results (SEER) codes available at: http://seer.cancer.gov/siterecode/icdo3.d01272003/
[c]Number of firefighters with cancer type.
[b]All models adjusted for age, calendar period of diagnosis, race, and an indicator of socio-economic status for the census block of residence. Excluded from control groups were cancers of the lung and bronchus, bladder and prostate, colo-rectal cancers, and skin melanomas.

FIGURE 4: RESULTS FROM THE 2014 STUDY BY DANIELS ET AL [40]

Table 3 Standardised mortality and incidence ratios among men compared with the US population for causes of a priori interest

	Mortality (1950–2009)				Cancer incidence (1985–2009)*			
	Caucasian		Other		Caucasian		Other	
Underlying cause (ICD-10 codes)	Obs	SMR (95% CI)	Obs	SMR (95% CI)	Obs	SIR (95% CI)	Obs	SIR (95% CI)
All causes	11 549	1.01 (0.99 to 1.03)	453	0.68 (0.62 to 0.74)	NA	NA	NA	NA
All cancers (C00-C97)	3175	1.16 (1.12 to 1.20)	104	0.80 (0.65 to 0.97)	4181	1.10 (1.07 to 1.13)	240	0.92 (0.81 to 1.05)
MN oesophagus (C15)	110	1.46 (1.20 to 1.75)	<5	0.51 (0.11 to 1.49)	87	1.70 (1.36 to 2.09)	<5	0.73 (0.15 to 2.15)
MN stomach (C16)	105	1.12 (0.92 to 1.36)	5	0.81 (0.26 to 1.89)	87	1.19 (0.96 to 1.47)	6	0.76 (0.28 to 1.66)
MN intestine (C17-C18)	319	1.32 (1.18 to 1.48)	7	0.68 (0.27 to 1.40)	379	1.23 (1.11 to 1.36)	18	0.90 (0.53 to 1.42)
MN rectum (C19-C21)	86	1.46 (1.17 to 1.81)	<5	1.21 (0.25 to 3.53)	159	1.16 (0.99 to 1.36)	7	0.62 (0.25 to 1.28)
MN lung (C33-C34)	1019	1.12 (1.05 to 1.19)	27	0.67 (0.44 to 0.97)	689	1.15 (1.07 to 1.24)	24	0.67 (0.43 to 1.00)
MN breast (C50)	5	1.43 (0.46 to 3.34)	0	NC	6	0.79 (0.29 to 1.72)	<5	3.32 (0.40 to 12.00)
MN prostate (C61)	265	1.06 (0.94 to 1.20)	17	1.64 (0.95 to 2.63)	1167	1.02 (0.96 to 1.08)	94	1.26 (1.02 to 1.54)
MN other male genital (C60, C62-C63)	<5	0.49 (0.13 to 1.26)	0	NC	16	0.64 (0.37 to 1.04)	<5	0.38 (0.01 to 2.13)
MN kidney (C64-C66)	91	1.31 (1.05 to 1.60)	<5	1.05 (0.22 to 3.07)	151	1.26 (1.06 to 1.47)	14	1.46 (0.80 to 2.45)
MN bladder (C67-C68)†	80	0.96 (0.76 to 1.19)	<5	1.19 (0.14 to 4.30)	305	1.11 (0.99 to 1.24)	7	0.92 (0.37 to 1.91)
MN brain (C47, C70-C72)	72	1.03 (0.81 to 1.30)	<5	0.44 (0.01 to 2.47)	49	1.05 (0.78 to 1.39)	<5	0.67 (0.08 to 2.42)
NHL (C46.3, C82-C85, C88.0, C88.3, C91.4, C96)‡	119	1.18 (0.98 to 1.41)	<5	1.01 (0.28 to 2.60)	161	1.02 (0.87 to 1.19)	7	0.56 (0.23 to 1.16)
Leukaemia (C91.0-C91.3, C91.5-C91.9, C92-C95)	117	1.10 (0.91 to 1.32)	5	1.28 (0.41 to 2.98)	88	0.88 (0.71 to 1.09)	11	1.90 (0.95 to 3.40)
Multiple myeloma (C88.7, C88.9, C90)	41	0.92 (0.66 to 1.25)	<5	0.35 (0.01 to 1.97)	35	0.76 (0.53 to 1.06)	<5	0.24 (0.01 to 1.32)
COPD (J40-J44)	362	0.73 (0.65 to 0.81)	5	0.50 (0.16 to 1.16)	NA	NA	NA	NA

*Incidence results based on analysis of all invasive primary cancers (ie, multiple-cancer approach).
†Urinary bladder incidence included in situ (D09.0) and invasive cases as per SEER protocol.
‡NHL incidence data exclude Kaposi sarcoma (C46.3).
COPD, chronic obstructive pulmonary disease; ICD-10, International Classification of Diseases, 10th Revision; MN, malignancy; NA, not applicable; NC, not calculated; NHL, non-Hodgkin lymphoma; Obs, observed; SIR, standardised incidence ratio; SEER, Surveillance, Epidemiology, and End Results; SMR, standardised mortality ratio.

FIGURE 5: RESULTS FROM THE 2016 STUDY BY GLASS ET AL [34]

Table 3 SIRs and 95% CIs for firefighters to 31 December 2010 compared with the Australian population

		Full time (n=17 002)			Part time (n=12 012)			All firefighters (n=29 014)		
Cancer categories	ICD-10 codes	O	E	SIR (95% CI)	O	E	SIR (95% CI)	O	E	SIR (95% CI)
All malignancies	C00–C43, C45–C50, C60–C97, D45–D46, D47.1, D47.3	**1208**	**1121.04**	**1.08 (1.02 to 1.14)**	**485**	**438.83**	**1.11 (1.01 to 1.21)**	**1693**	**1559.87**	**1.09 (1.03 to 1.14)**
Lip, oral cavity and pharynx	C00–C14	55	58.12	0.95 (0.71 to 1.23)	21	23.57	0.89 (0.55 to 1.36)	76	81.69	0.93 (0.73 to 1.16)
Digestive organs	C15–C25	230	230.08	1.00 (0.87 to 1.14)	85	85.68	0.99 (0.79 to 1.23)	315	315.75	1.00 (0.89 to 1.11)
Oesophagus	C15	12	15.79	0.76 (0.39 to 1.33)	5	5.90	0.85 (0.28 to 1.98)	17	21.68	0.78 (0.46 to 1.26)
Stomach	C16	24	24.54	0.98 (0.63 to 1.46)	9	8.73	1.03 (0.47 to 1.96)	33	33.27	0.99 (0.68 to 1.39)
Colorectal	C18–C21	157	144.65	1.09 (0.92 to 1.27)	57	53.74	1.06 (0.80 to 1.37)	214	198.39	1.08 (0.94 to 1.23)
Colon	C18	92	81.48	1.13 (0.91 to 1.38)	27	29.61	0.91 (0.60 to 1.33)	119	111.09	1.07 (0.89 to 1.28)
Rectum	C20	55	46.43	1.18 (0.89 to 1.54)	21	17.82	1.18 (0.73 to 1.80)	76	64.25	1.18 (0.93 to 1.48)
Liver	C22	8	15.34	0.52 (0.23 to 1.03)	4	6.23	0.64 (0.17 to 1.64)	**12**	**21.57**	**0.56 (0.29 to 0.97)**
Pancreas	C25	22	20.55	1.07 (0.67 to 1.62)	7	7.56	0.93 (0.37 to 1.91)	29	28.11	1.03 (0.69 to 1.48)
Respiratory	C30–C38	**100**	**122.95**	**0.81 (0.66 to 0.99)**	**17**	**41.67**	**0.41 (0.24 to 0.65)**	**117**	**164.62**	**0.71 (0.59 to 0.85)**
Larynx	C32	11	12.74	0.86 (0.43 to 1.54)	1	4.42	0.23 (0.01 to 1.26)	12	17.16	0.70 (0.36 to 1.22)
Lung	C33–C34	86	106.57	0.81 (0.65 to 1.00)	**15**	**35.73**	**0.42 (0.23 to 0.69)**	**101**	**142.30**	**0.71 (0.58 to 0.86)**
Melanoma	C43	**209**	**144.31**	**1.45 (1.26 to 1.66)**	**89**	**62.37**	**1.43 (1.15 to 1.76)**	**298**	**206.69**	**1.44 (1.28 to 1.62)**
Mesothelioma	C45	11	8.30	1.33 (0.66 to 2.37)	4	2.91	1.38 (0.37 to 3.52)	15	11.20	1.34 (0.75 to 2.21)
Male reproductive	C60–C63	**357**	**298.15**	**1.20 (1.08 to 1.33)**	**167**	**118.78**	**1.41 (1.20 to 1.64)**	**524**	**416.94**	**1.26 (1.15 to 1.37)**
Prostate	C61	**325**	**263.93**	**1.23 (1.10 to 1.37)**	**153**	**101.01**	**1.51 (1.28 to 1.77)**	**478**	**364.94**	**1.31 (1.19 to 1.43)**
Testis	C62	31	21.48	1.44 (0.98 to 2.05)	12	12.87	0.93 (0.48 to 1.63)	43	34.35	1.25 (0.91 to 1.69)
Urinary tract	C64–C68	59	64.91	0.91 (0.69 to 1.17)	25	24.07	1.04 (0.67 to 1.53)	84	88.98	0.94 (0.75 to 1.17)
Kidney	C64	33	34.09	0.97 (0.67 to 1.36)	19	14.13	1.34 (0.81 to 2.10)	52	48.23	1.08 (0.81 to 1.41)
Bladder	C67	23	27.14	0.85 (0.54 to 1.27)	5	8.71	0.57 (0.19 to 1.34)	28	35.85	0.78 (0.52 to 1.13)
Brain and other CNS	C70–C72	17	21.89	0.78 (0.45 to 1.24)	13	9.47	1.37 (0.73 to 2.35)	30	31.36	0.96 (0.65 to 1.37)
Brain	C71	16	20.96	0.76 (0.44 to 1.24)	12	9.06	1.32 (0.68 to 2.31)	28	30.02	0.93 (0.62 to 1.35)
Thyroid and other endocrine	C73–C75	13	12.04	1.08 (0.58 to 1.85)	7	6.03	1.16 (0.47 to 2.39)	20	18.07	1.11 (0.68 to 1.71)
Thyroid	C73	13	11.05	1.18 (0.63 to 2.01)	7	5.56	1.26 (0.51 to 2.59)	20	16.61	1.20 (0.74 to 1.86)
Unknown site	C76–C80, C26, C39	27	27.29	0.99 (0.65 to 1.44)	6	9.31	0.64 (0.24 to 1.40)	33	36.60	0.90 (0.62 to 1.27)
Lympho-haematopoietic	C81–C96, D45–D46, D47.1, D47.3	109	114.25	0.95 (0.78 to 1.15)	43	47.17	0.91 (0.66 to 1.23)	152	161.42	0.94 (0.80 to 1.10)
Hodgkin disease	C81	6	6.57	0.91 (0.34 to 1.99)	4	3.52	1.14 (0.31 to 2.91)	10	10.08	0.99 (0.48 to 1.82)
Non-Hodgkin lymphoma	C82–C85	47	48.04	0.98 (0.72 to 1.30)	19	19.93	0.95 (0.57 to 1.49)	66	67.96	0.97 (0.75 to 1.24)
Myeloma	C90	15	13.11	1.14 (0.64 to 1.89)	3	4.94	0.61 (0.13 to 1.78)	18	18.04	1.00 (0.59 to 1.58)
Leukaemia	C91–C95	28	30.52	0.92 (0.61 to 1.33)	15	12.40	1.21 (0.68 to 2.00)	43	42.92	1.00 (0.73 to 1.35)
Myelodysplastic syndrome	D46	4	4.40	0.91 (0.25 to 2.33)	0	1.60	–	4	6.00	0.67 (0.18 to 1.71)
All other cancers	C40–42, C46–50, C69, C97	21	18.76	1.12 (0.69 to 1.71)	8	7.79	1.03 (0.44 to 2.02)	29	26.55	1.09 (0.73 to 1.57)
Male breast	C50	5	2.01	2.49 (0.81 to 5.82)	1	0.76	1.31 (0.03 to 7.32)	6	2.77	2.17 (0.80 to 4.72)

Bold/not bold was to show groups and subsets.
CNS, central nervous system; ICD International Classification of Diseases.

FIGURE 6: RESULTS FROM THE 2014 STUDY BY PUKKALA ET AL [43]

Table 1 Cancer incidence among 16 422 male Nordic firefighters, follow-up 1961–2005

Cancer site (ICD-10)	Observed	SIR	95% CI
All cancers	2536	1.06	1.02 to 1.11
Lip (C00)	17	0.80	0.46 to 1.28
Tongue (C01–02)	11	1.04	0.52 to 1.87
Salivary glands (C07–08)	10	1.69	0.81 to 3.11
Oral cavity (C03–06)	11	0.80	0.40 to 1.43
Pharynx (C09–14)	19	1.00	0.60 to 1.57
Oesophagus (C15)	31	0.98	0.66 to 1.39
Stomach (C16)	128	1.09	0.91 to 1.30
Small intestine (C17)	13	1.15	0.61 to 1.97
Colon (C18)	198	1.14	0.99 to 1.31
Rectum, rectosigma (C19–21)	119	0.99	0.82 to 1.19
Primary liver (C22)	25	0.91	0.59 to 1.34
Gallbladder (C23–24)	18	1.45	0.86 to 2.29
Pancreas (C25)	87	1.17	0.94 to 1.45
Larynx (C32)	31	1.06	0.72 to 1.50
Lung (C33–34)	310	0.97	0.87 to 1.09
Adenocarcinoma	80	1.29	1.02 to 1.60
Squamous cell carcinoma	90	0.88	0.71 to 1.08
Small cell carcinoma	34	0.83	0.58 to 1.16
Skin melanoma (C43)	109	1.25	1.03 to 1.51
Mesothelioma (C45)	17	1.55	0.90 to 2.48
Soft tissue (C48–49)	18	1.16	0.69 to 1.84
Penis (C60)	12	1.53	0.79 to 2.67
Prostate (C61)	660	1.13	1.05 to 1.22
Testicular (C62)	9	0.51	0.23 to 0.98
Kidney (C64–65)	84	0.94	0.75 to 1.17
Bladder (C66–68)	194	1.11	0.96 to 1.28
Brain (C70–71)	64	0.86	0.66 to 1.10
Glioma	33	0.92	0.64 to 1.30
Thyroid (C73)	17	1.28	0.75 to 2.05
Non-Hodgkin lymphoma (C82–85, C96)	82	1.04	0.83 to 1.29
Multiple myeloma (C90)	41	1.13	0.81 to 1.53
Leukaemia (C91–95)	56	0.94	0.71 to 1.22
Acute myeloid	21	1.27	0.79 to 1.94
Not included above			
Non-melanoma skin cancer* (C44)	117	1.33	1.10 to 1.59

*Excludes Denmark.

Health Monitoring Organization Chart

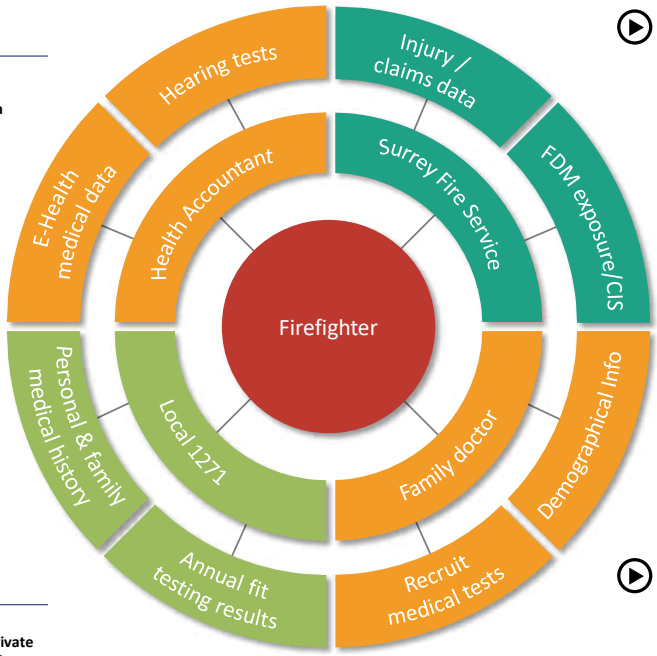
Surrey Fire Service

Problem

The current model for firefighter wellness, the IAFF/IAFC Wellness Fitness Initiative, relies on a variety of in-house and public health services. The system is difficult to navigate, takes an expensive, blanket approach to screening, and does not provide firefighters with a complete picture of their health. The result is that many firefighters suffer with preventable health problems and die younger than they should.

Purpose

Create a tool to help firefighters proactively monitor all aspects of their health, so that they can identify and address issues as early as possible and live a long and healthy life.



Deliverable (phase 1 – 2017)

Personalized, comprehensive and private online health accounts with optional medical oversight.

How it would work

Each firefighter would have a private health account populated with personalized health data, including but not limited to:

References

[1] Government of Canada. CCOHS: Canadian Centre for Occupational Health and Safety. Available from: http://www.ccohs.ca/ (accessed 11 November 2017).

[2] World Health Organization. Global strategy on occupational health for all: The way to health at work. Available from: http://www.who.int/occupational_health/publications/globstrategy/en/index1.html (accessed 14 November 2017).

[3] Statistics Canada. Highlights. Available from: https://www.statcan.gc.ca/pub/89-647-x/2011001/hl-fs-eng.htm#a1 (accessed 11 November 2017).

[4] The Organisation for Economic Co-operation and Development. Better Life Index. Available from: http://www.oecdbetterlifeindex.org/countries/canada/ (accessed 14 November 2017).

[5] Statistics Canada. Work injuries: Findings. Available from: http://www.statcan.gc.ca/pub/82-003-x/2006007/article/injuries-blessures/4149017-eng.htm (accessed 11 November 2017)

[6] Government of Canada. Canadian Centre for Occupational Health and Safety. Fire Fighter : OSH Answers. Available from: http://www.ccohs.ca/ (2017, accessed 11 November 2017).

[7] WorkSafeBC. OHS Regulation: Part 31- Firefighting. Available from: https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-31-firefighting (accessed 11 November 2017).

[8] Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998; 52: 377–384.

[9] Reichard AA, Jackson LL. Occupational injuries among emergency responders. *Am J Ind Med* 2010; 53: 1–11.

[10] Taylor NAS, Dodd MJ, Taylor EA, et al. A Retrospective Evaluation of Injuries to Australian Urban Firefighters (2003 to 2012): Injury Types, Locations, and Causal Mechanisms. *J Occup Environ Med* 2015; 57: 757–764.

[11] Yoon JH, Kim YK, Kim KS, et al. Characteristics of Workplace Injuries among Nineteen Thousand Korean Firefighters. *J Korean Med Sci* 2016; 31: 1546–1552.

[12] Jahnke SA, Poston WSC, Haddock CK, et al. Injury among a population based sample of career firefighters in the central USA. *Inj Prev* 2013; 19: 393–398.

[13] Katsavouni F, Bebetsos E, Malliou P, et al. The relationship between burnout, PTSD symptoms and injuries in firefighters. *Occup Med* 2016; 66: 32–37.

[14] Suyama J, Rittenberger JC, Patterson PD, et al. Comparison of public safety provider injury rates. *Prehospital Emerg Care Off J Natl Assoc EMS Physicians Natl Assoc State EMS Dir* 2009; 13: 451–455.

[15] Ahn Y-S, Jeong KS. Mortality Due to Malignant and Non-Malignant Diseases in Korean Professional Emergency Responders. *PLOS ONE* 2015; 10: e0120305.

[16] Bos J, Mol E, Visser B, et al. Risk of health complaints and disabilities among Dutch firefighters. *Int Arch Occup Environ Health*; 77. Epub ahead of print August 2004. DOI: 10.1007/s00420-004-0537-y.

[17] Hong O, Chin DL, Phelps S, et al. Occupational Injuries, Duty Status, and Factors Associated With Injuries Among Firefighters. *Workplace Health Saf* 2012; 60: 517–523.

[18] Britton C, Ramirez M, Lynch CF, et al. Risk of injury by job assignment among federal wildland firefighters, United States, 2003–2007. *Int J Occup Environ Health* 2013; 19: 77–84.

[19] Vaulerin J, d'Arripe-Longueville F, Emile M, et al. Physical exercise and burnout facets predict injuries in a population-based sample of French career firefighters. *Appl Ergon* 2016; 54: 131–135.

[20] Baarts C, Mikkelsen KL, Hannerz H, et al. Use of a national hospitalization register to identify industrial sectors carrying high risk of severe injuries: a three-year cohort study of more than 900,000 Danish men. *Am J Ind Med* 2000; 38: 619–627.

[21] Baris D, Garrity TJ, Telles JL, et al. Cohort mortality study of Philadelphia firefighters. *Am J Ind Med* 2001; 39: 463–476.

[22] Mechem CC, Dickinson ET, Shofer FS, et al. Injuries from assaults on paramedics and firefighters in an urban emergency medical services system. *Prehospital Emerg Care Off J Natl Assoc EMS Physicians Natl Assoc State EMS Dir* 2002; 6: 396–401.

[23] Kahn SA, Woods J, Rae L. Line of Duty Firefighter Fatalities: An Evolving Trend Over Time. *J Burn Care Res* 2015; 36: 218–224.

[24] Ma F, Fleming LE, Lee DJ, et al. Mortality in Florida professional firefighters, 1972 to 1999. *Am J Ind Med* 2005; 47: 509–517.

[25] Hodous TK. Fire fighter fatalities 1998-2001: overview with an emphasis on structure related traumatic fatalities. *Inj Prev* 2004; 10: 222–226.

[26] Amadeo B, Marchand J-L, Moisan F, et al. French firefighter mortality: Analysis over a 30-year period. *Am J Ind Med* 2015; 58: 437–443.

[27] Wagner NL, Berger J, Flesch-Janys D, et al. Mortality and life expectancy of professional fire fighters in Hamburg, Germany: a cohort study 1950-2000. *Environ Health Glob Access Sci Source* 2006; 5: 27.

[28] Martha Dow, Kenneth Kunz, Len Garis and Larry Thomas, Firefighters and Cancer: Understanding Risk Factors in an Environment of Change, University of the Fraser Valley, Centre for Public Safety & Criminal Justice Research, 2015. (available online: https://www.ufv.ca/media/assets/criminal-justice-research/Firefighters-and-Cancer.pdf)

[29] Steenland K, Burnett C, Lalich N, et al. Dying for work: The magnitude of US mortality from selected causes of death associated with occupation. *Am J Ind Med* 2003; 43: 461–482.

[30] Straif K, Baan R, Grosse Y, et al. Carcinogenicity of shift-work, painting, and fire-fighting. *Lancet Oncol* 2007; 8: 1065–1066.

[31] Glass DC, Pircher S, Del Monaco A, et al. Mortality and cancer incidence in a cohort of male paid Australian firefighters. *Occup Environ Med* 2016; 73: 761–771.

[32] Daniels RD, Bertke S, Dahm MM, et al. Exposure-response relationships for select cancer and non-cancer health outcomes in a cohort of U.S. firefighters from San Francisco, Chicago and Philadelphia (1950-2009). *Occup Environ Med* 2015; 72: 699–706.

[33] Bigert C, Gustavsson P, Straif K, et al. P025 Lung cancer risk among firefighters when accounting for tobacco smoking – preliminary results from a pooled analysis of case-control studies from europe, canada, new zealand and china. *Occup Env Med* 2016; 73: A128–A128.

[34] Ide CW. Cancer incidence and mortality in serving whole-time Scottish firefighters 1894-2005. *Occup Med* 2014; 64; 421-427

[35] Ahn Y-S, Jeong K-S, Kim K-S. Cancer morbidity of professional emergency responders in Korea. *Am J Ind Med* 2012; 55: 768–778.

[36] Bates MN. Registry-based case–control study of cancer in California firefighters. *Am J Ind Med* 2007; 50: 339–344.

[37] Daniels RD, Kubale TL, Yiin JH, et al. Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950–2009). *Occup Env Med* 2014; 71: 388–397.

[38] LeMasters GK, Genaidy AM, Succop P, et al. Cancer Risk Among Firefighters: A Review and Meta-analysis of 32 Studies. *J Occup Environ Med* 2006; 48: 1189–1202.

[39] Paget-Bailly S, Guida F, Carton M, et al. Occupation and head and neck cancer risk in men: results from the ICARE study, a French population-based case-control study. *J Occup Environ Med* 2013; 55: 1065–1073.

[40] Pukkala E, Martinsen JI, Weiderpass E, et al. Cancer incidence among firefighters: 45 years of follow-up in five Nordic countries. *Occup Environ Med* 2014; 71: 398-404

[41] Tsai RJ, Luckhaupt SE, Schumacher P, et al. Risk of cancer among firefighters in California, 1988-2007. *Am J Ind Med* 2015; 58: 715–729.

[42] Hylton J.G. Haynes and Joseph L. Molis, United States Firefighter Injuries – 2016, October 2017, Quincy: National Fire Protection Association, Research, Data and Analytics Division. (accessed 10 December 2017).

[43] Britton C, Lynch CF, Ramirez M, et al. Epidemiology of injuries to wildland firefighters. *Am J Emerg Med* 2013; 31: 339–345.

[44] Clark WW, Bohl CD. Hearing levels of firefighters: risk of occupational noise–induced hearing loss assessed by cross-sectional and longitudinal data. *Ear Hear* 2005; 26: 327–340.

[45] Hong O, Samo DG. Hearing loss and use of hearing protection among career firefighters in the United States. *J Occup Environ Med* 2013; 55: 960–965.

[46] Public Health Agency of Canada (ed). *2009 tracking heart disease and stroke in Canada*. Ottawa: Public Health Agency of Canada, 2009.

[47] Soteriades ES, Smith DL, Tsismenakis AJ, et al. Cardiovascular disease in US firefighters: a systematic review. *Cardiol Rev* 2011; 19: 202–215.

[48] Kales SN, Smith DL. Firefighting and the Heart: Implications for Prevention. *Circulation* 2017; 135: 1296–1299.

[49] Fahy RF. US Firefighter Fatalties Due to Sudden Cardiac Death, 1995-2004. *Quincy MA Natl Fire Prot Assoc*.

[50] Sen S, Palmieri T, Greenhalgh D. Cardiac Fatalities in Firefighters: An Analysis of the U.S. Fire Administration Database. *J Burn Care Res Off Publ Am Burn Assoc* 2016; 37: 191–195.

[51] Farioli A, Yang J, Teehan D, et al. Duty-related risk of sudden cardiac death among young US firefighters. *Occup Med* 2014; 64: 428–435.

[52] Kales SN, Soteriades ES, Christophi CA, et al. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med* 2007; 356: 1207–1215.

[53] Drew-Nord DC, Hong O, Froelicher ES. Cardiovascular risk factors among career firefighters. *AAOHN J Off J Am Assoc Occup Health Nurses* 2009; 57: 415–422.

[54] Farioli A, Christophi CA, Quarta CC, et al. Incidence of Sudden Cardiac Death in a Young Active Population. *J Am Heart Assoc* 2015; 4: e001818.

[55] Kales SN, Soteriades ES, Christoudias SG, et al. Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ Health* 2003; 2: 14.

[56] Wolkow A, Netto K, Langridge P, et al. Coronary Heart Disease Risk in Volunteer Firefighters in Victoria, Australia. *Arch Environ Occup Health* 2014; 69: 112–120.

[57] Yang J, Teehan D, Farioli A, et al. Sudden cardiac death among firefighters ≤45 years of age in the United States. *Am J Cardiol* 2013; 112: 1962–1967.

[58] Henneberger P, Metayer C, Layne L, et al. Nonfatal work-related inhalations: surveillance data from hospital emergency departments, 1995-1996. *Am J Ind Med* 2000*;* 28: 140-148.

[59] Schermer TR, Malbon W, Adams R, et al. Change in lung function over time in male metropolitan firefighters and general population controls: a 3-year follow-up study. *J Occup Health* 2013; 55: 267–275.

[60] Schermer TR, Malbon W, Morgan M, et al. Chronic respiratory conditions in a cohort of metropolitan fire-fighters: associations with occupational exposure and quality of life. *Int Arch Occup Environ Health* 2014; 87: 919–928.

[61] Crawford A. Researchers find significantly higher rate of mental disorders among first responders. CBC News. 2017 Aug 30 (accessed 10 December 2017)¨. Available from: http://www.cbc.ca/news/politics/police-fire-fighters-ptsd-paramedis-1.4266720.

[62] Lima Ede P,, Assuncao AA, Barreto SM. Prevalence of depression among firefighters. *Cad Saude Publica* 2015; 31: 733-343

[63] Carey MG, Al-Zaiti SS, Dean GE, et al. Sleep problems, depression, substance use, social bonding, and quality of life in professional firefighters. *J Occup Environ Med Coll Occup Environ Med* 2011; 53: 928.

[64] Kaufmann CN, Rutkow L, Spira AP, et al. Mental Health of Protective Services Workers: Results From the National Epidemiologic Survey on Alcohol and Related Conditions. *Disaster Med Public Health Prep* 2013; 7: 36–45.

[65] Stanley IH, Hom MA, Joiner TE. Suicide mortality among firefighters: Results from a large, urban fire department. *Am J Ind Med* 2016; 59: 942–947.

[66] Stanley IH, Hom MA, Hagan CR, et al. Career prevalence and correlates of suicidal thoughts and behaviors among firefighters. *J Affect Disord* 2015; 187: 163–171.

[67] Stanley IH, Hom MA, Spencer-Thomas S, et al. Suicidal thoughts and behaviors among women firefighters: An examination of associated features and comparison of pre-career and career prevalence rates. *J Affect Disord* 2017; 221: 107–114.

[68] Association of Workers' Compensation Boards of Canada. 2015 Injury Statistics Across Canada. Available from: http://awcbc.org/?page_id=14 (accessed 10 December 2017).

[69] Government of Canada. The 10 leading causes of death, 2013. Available from: https://www.statcan.gc.ca/pub/82-625-x/2017001/article/14776-eng.htm (accessed 20 January 2018).

[70] Canadian Cancer Society. Canadian Cancer Statistics 2017. *Available from:* http://www.cancer.ca/en/cancer-information/cancer-101/canadian-cancer-statistics-publication/?region=on (accessed 10 December 2017).

[71] Government of Canada. Health Status of Canadians 2016: Report of the Chief Public Health Officer - How are we unhealthy? - Cardiovascular disease. Available from:https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/2016-health-status-canadians/page-17-how-are-we-unhealthy-cardiovascular-disease.html (2016, accessed 10 December 2017).

[72] Government of Canada. Heart disease – heart health. Available from: https://www.canada.ca/en/public-health/services/diseases/heart-disease-heart-health.html (2013, accessed 10 December 2017).

[73] The Heart Research Institute. Facts about Heart Disease. Available from: http://www.hricanada.org/about-heart-disease/facts-about-heart-disease (accessed 10 December 2017).

[74] How Canada Perfoms, Mortality Due to Respiratory Diseases - Health Provincial Ranking[with data from Statistics Canada; the Conference Board of Canada]. Available from: http://www.conferenceboard.ca/hcp/provincial/health/resp.aspx (accessed 10 December 2017).

[75] Mental Health Commission of Canada. The Facts: Mental Health. Available from:vhttp://strategy.mentalhealthcommission.ca/the-facts/ (accessed 11 November 2017).

[76] Rosenstock L, Olsen J. Firefighting and death from cardiovascular causes. *N Engl J Med* 2007; 356: 1261–1263.

[77] Haas NS, Gochfeld M, Robson MG, et al. Latent Health Effects in Firefighters. *Int J Occup Environ Health* 2003; 9: 95–103.

[78] Estes CR, Marsh SM, Castillo DN. Surveillance of Traumatic Firefighter Fatalities: An Assessment of Four Systems. *Public Health Rep* 2011; 126: 540–551.

[79] Health Canada. Injury Surveillance in Canada: Current Realities and Challenges (2003) Available from: http://www.injuryresearch.bc.ca/docs/3_20090910_100541Report%20HC%20Inj%20Surveillance%20in%20Can%20Aug%202003.pdf (accessed 12 December 2017).

[80] World Health Organization. Injury surveillance guidelines. Available from: http://www.who.int/violence_injury_prevention/publications/surveillance/surveillance_guidelines/en/ (accessed 12 December 2017).

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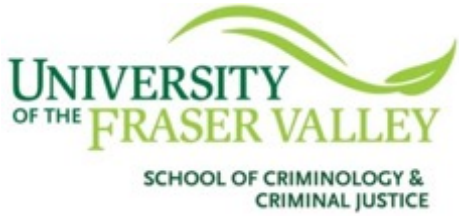
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