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Occupational Safety and Health for Public Safety Employees

Assessing the Evidence and the
Implications for Public Policy

Tom LaTourrette, David S. Loughran, Seth A. Seabury

Co-sponsored by the California Commission on
Health and Safety and Workers' Compensation and the
National Institute for Occupational Safety and Health



INSTITUTE FOR CIVIL JUSTICE and
INFRASTRUCTURE, SAFETY, AND ENVIRONMENT

This research was co-sponsored by the California Commission on Health and Safety and Workers' Compensation (CHSWC) and the National Institute for Occupational Safety and Health (NIOSH) and was conducted under the auspices of the RAND Institute for Civil Justice (ICJ) and the Safety and Justice Program within RAND Infrastructure, Safety, and Environment (ISE).

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Preface

The provision of public safety is one of the most important responsibilities of government, and workers charged with protecting the public, such as police officers and firefighters, are routinely asked to put their own lives at risk. As such, it is no surprise that public safety employees tend to face some of the highest risks of fatal and nonfatal injury. It is therefore an important goal of policymakers to determine ways to help protect public safety employees from work-related illnesses and disease without compromising their ability to do their jobs.

This report contributes to this goal by providing an in-depth study of the adverse health risks faced by public safety employees. We conducted thorough literature reviews and new data analysis to detail the frequency and severity of different illnesses and injuries suffered by public safety employees of different ages. We complemented this work with a series of roundtable discussions with numerous public safety personnel, to better understand the opportunities and challenges surrounding policies intended to reduce injuries and illnesses among police officers and firefighters.

This research was co-sponsored by the California Commission on Health and Safety and Workers' Compensation (CHSWC) and the National Institute for Occupational Safety and Health (NIOSH). This project was conducted within two research divisions at RAND.

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Summary

Introduction

Public safety employees are routinely asked to put their own lives and well-being at risk in order to protect the life and property of ordinary citizens. As a result, they face injury and fatality rates that are as much as three times higher than those faced by workers in non-safety occupations. These high levels of risk have motivated considerable efforts to identify the nature and causes of occupational health risks to public safety personnel, in order to better understand how to take steps to reduce these risks. However, such efforts require a comprehensive understanding of the specific risk factors associated with different aspects of public safety occupations.

The objective of this study, which was funded by both the California Commission on Health and Safety and Workers' Compensation (CHSWC) and the National Institute for Occupational Safety and Health (NIOSH), was to aid in the design of effective safety interventions by characterizing the important safety and health risks faced by public safety personnel and how those risks differ from those faced by non-safety personnel. To accomplish this, we pursued the following research goals:

- Summarize the existing literature on the injury and fatality risks to public safety employees.
- Characterize the perceived risks and the efforts currently used by public safety departments to reduce those risks.
- Describe the differences in the rates of injury, disability, and other chronic health problems for workers in public safety occupations compared with workers in other occupations.

Our work helps to identify the opportunities and challenges that policymakers and employers face in improving the workplace safety of public safety employees. A majority of our focus is on police officers and firefighters, which are the two most common safety occupations. However, when data are available, we also consider other occupations, such as emergency medical service (EMS) responders and correctional facility officers.

Methods

To accomplish the goals of this study, we combined several different approaches. To categorize the existing knowledge of the health and safety risks of public safety employees, we conducted a thorough review of the existing literature and surveillance data. To characterize perceptions of risk and understand risk-mitigation efforts, we conducted roundtable discussions with public safety personnel from a number of police and fire departments in California. These roundtable discussions helped us to evaluate current efforts and identify areas with the most potential to improve safety and health for public safety employees. In order to study differences in chronic health conditions and work-related disability between public safety and non-safety employees, we used two sources of data. First we examined national survey databases to compare the rates of disability and chronic disease experienced by safety employees with those of non-safety employees. We also used administrative data from a sample of California public employees that included information on work-related permanent disability benefit claims and disability retirement for public safety and other personnel.

One of the key methodological issues we faced was overcoming inconsistencies in reporting between public safety workers and other workers that are driven by institutional factors, specifically compensation mechanisms. For example, in most cases and in most occupations, illnesses such as heart disease are not considered job-related in nature. However, for many firefighters, heart disease (as well as respiratory disease and certain cancers) is presumed to be job-related unless the employer is able to prove otherwise. This leads to many fatalities

involving heart disease being reported as job-related for firefighters, and substantially complicates the comparison of health and safety risks across occupations. A similar issue arises with regards to disability claims: Public safety employees are typically eligible for disability retirement benefits that are unavailable to non-safety workers. This can lead to reporting biases, which make it difficult to calculate injury and disability rates and to distinguish work-related conditions from non-work-related conditions. When possible, we attempted to circumvent this problem by focusing our analyses on data for which health conditions and disability are recorded comparably between the different occupations.

Findings

Our central findings can be grouped into four separate categories: (1) characterizing the central occupational health risks to different public safety occupations, (2) describing current efforts at improving safety and identifying areas that represent the most promising targets for reform, (3) comparing the self-reported health of public safety employees with that of workers in non-safety occupations, and (4) examining differences in work-related disability claim rates of public safety employees and non-safety employees by age.

Characterizing the Occupational Health Risks to Public Safety Employees

Our knowledge about the primary safety and health risks faced by public safety employees in different occupations is limited by the available data. The data available for fatal injuries are far more complete, and as a result far more is known about the causes of and circumstances surrounding fatalities. For instance, up to 50 percent of firefighter deaths are attributed to heart attacks, with vehicle accidents a distant second (about 20 percent). For law enforcement, approximately 37 percent of fatalities are attributable to vehicle accidents, and another 37 percent are attributable to assaults. This highlights the difficulty in generalizing safety and health risks, since they vary so much by occupation.

While much is known about the fatal injury risks faced by public safety employees, there are substantial gaps in our knowledge about their nonfatal injury and illness rates. Given that nonfatal injuries are far more common and amount to a much greater share of employer costs, this is an important deficiency in surveillance. Nationwide data on nonfatal firefighter injuries are collected, but there is very little widespread data reporting on nonfatal injuries or illnesses for other safety occupations. The data that do exist suggest that injury risks vary according to the specific duties that different public safety workers are engaged in. However, one finding that generalizes across the different services is that injuries are dominated heavily by strains and sprains, largely involving musculoskeletal disorders.

Identifying Areas that Provide the Best Opportunity for Reform

We used a qualitative approach integrating information about safety and health risks with information on existing safety and health promotion efforts to examine the extent to which these initiatives align with the known risks that public safety employees face. This approach incorporated insights from a series of roundtable discussions with public safety workers from different departments in California. These methods allowed us to identify the perceived safety and health concerns of public safety workers, compare these concerns with the safety and health interventions in use, and identify areas that are perceived as likely candidates for reform.

The priorities for improving safety can vary depending on the criteria one is using for evaluation. Table S.1 identifies the most important safety and health concerns for firefighters, EMS responders, and police according to four different classification criteria: frequency, severity as measured by fatal accidents, severity as measured by lost work time, and injuries by type of duty. When fatal injuries are the target, heart attacks and vehicle accidents are the greatest concerns for the fire service and vehicle accidents are the greatest concern for the emergency medical service. Vehicle crashes and assaults (primarily shootings) are the highest priority for the police. When the criterion is the number of cases or the amount of lost work time (a severity measure for nonfatal injuries, and one that is most relevant for reducing employer costs),

Table S.1
Safety and Health Priorities Across Occupations, by Severity, Frequency, and Type of Duty

Occupation	Frequency: Number of Cases (% of cases)	Severity: Most Common Fatal Injuries (% of injuries)	Severity: Most Common Lost Work Time Injuries (% of lost time)	Type of duty (% of fatal/ nonfatal injuries)
Firefighters	Strains and sprains (59%)	Heart attacks (48%); Vehicle accidents (22%)	Not available	Fireground operations (32%/53%)
EMS	Strains and sprains (55%) ^a	Vehicle accidents (77%)	Strains and sprains (63%) ^a	Driving (77%/19%); Lifting (0%/42%)
Police	Strains and sprains (64%; 42% of which are back)	Vehicle crashes (37%); Assaults (37%) ^b	Strains and sprains (63%; 33% of which are back)	Driving (37%/16%); Traffic stops and directing traffic (18%/not available)

^a Across all nonfatal injuries, the back is three times more likely to be injured than any other body part for EMS responders.

^b 94 percent of fatal assaults on police are shootings.

strains and sprains are the primary safety and health concern for all three services. Back injuries are the most common for EMS responders and the police.

A different way to classify casualties is by the type of duty the public safety employees were engaged in when injured. This classification helps target the activities that are associated with the biggest health risks. For firefighters, a majority of fatal and nonfatal injuries occur on the fireground, even though actual firefighting represents a relatively small proportion of the time spent on duty (considerably more time is spent on duty at the station, on non-emergency calls, or responding to non-fire emergencies). The most hazardous activity for EMS responders in terms of fatalities is driving, while for nonfatal injuries it is lifting and carrying patients. For police, driving is clearly the highest-risk activity, with activities conducted outside vehicles in traffic, such as traffic stops and directing traffic, also being high risk.

These findings provide a basis for guiding the design and prioritization of safety and health improvement efforts. Note, however, that the ability to design effective interventions is hampered by some severe limitations in the data on the nature and causes of injury. As such, one of the key opportunities for improving safety that arose in our roundtable discussions was to improve surveillance and monitoring systems. Improved training, modifications to protective equipment, and changes in culture and command guidance also emerged as promising tools for improving safety. However, there are a number of challenges that must be overcome in order to act on any of these items, such as budgetary restrictions and a general lack of evidence on the effectiveness of various implementation strategies.

Comparing the Health of Public Safety Employees with That of the General Population

One approach to quantifying the adverse health consequences experienced by public safety employees is to use national survey data that contain self-reports of chronic disease and disability regardless of whether or not the condition is job-related. Table S.2 compares the percentage of police officers, firefighters, or other workers reporting a work-limiting disability, leaving their job due to poor health, having

Table S.2
Incidence of Disability and Poor Health for Police, Firefighters, Corrections Officers, and Non-Safety Occupations

Occupation	Number of Observations	Health and Disability Measures (%)				
		Disabled	Left Job Because of Health	Have Poor Health	Receive Disability Income	Receive Workers' Comp. Income
Police	2,215	0.7	0.4	16.3	0.1	2.0
Fire	1,027	0.7	0.6	15.7	0.3	1.7
Corrections	813	1.6	1.0	25.2	0.4	2.1
Non-safety	202,709	2.1	1.0	26.9	0.2	0.9

SOURCE: March CPS, 2003–2007.
NOTE: Sample restricted to men age 18–50.

fair or poor health (as opposed to good or better), receiving disability income, or receiving workers' compensation income. Data come from the Current Population Survey (CPS), a large nationwide survey of detailed demographic and occupational statistics compiled by the U.S. Census Bureau. The table suggests that police and firefighters are less likely to be disabled than workers in other occupations. The percentage of police and firefighters reporting they have a disability that prevents or limits the kind of work they do is less than half that of other occupations (0.7 percent compared with 2.1 percent). They are also much less likely to report having poor health or leaving a job for health reasons. Corrections officers also appear somewhat healthier, though they appear more similar to non-safety employees.

Conversely, the table shows that the percentage of men receiving disability and workers' compensation income is higher among public safety workers than it is among other workers. For example, about 2 percent of police and correctional officers and 1.7 percent of firefighters report receiving workers' compensation income in the previous year. This compares with 0.9 percent of non-safety employees.

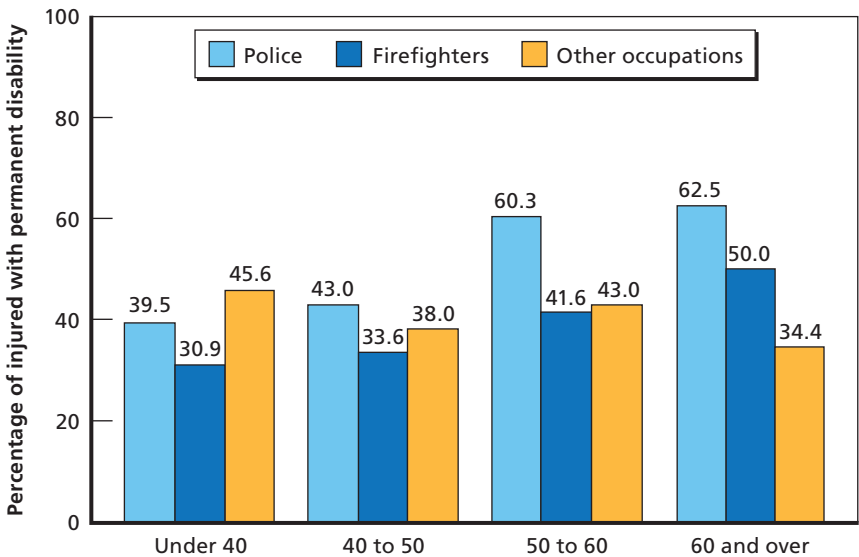
These findings indicate that public safety employees are less likely to be disabled or have poor health, despite their relatively high injury rates. These general findings were confirmed when we considered a second data source, the National Health Interview Survey (NHIS), which contains more detailed self-report information on health conditions and diseases. Police officers and firefighters were generally found to either have no difference or be less likely to suffer from disability or such adverse health conditions as pain, serious mental illness, or disease. The findings about risk factors were mixed: Police and fire employees were more likely to be obese but less likely to smoke. These results were confirmed even when other important demographic characteristics, such as age, race and education, were controlled for. There was some indication that older public safety workers in the NHIS sample are more likely to have had heart disease, which is noteworthy given the high fraction of occupational fatalities for firefighters that are attributed to heart attacks. However, the statistical significance of this relationship in our analysis is at best marginal, and further research would be required to confirm this finding.

Job-Related Disability Claims by Public Safety Employees

Among all nonfatal injuries, permanently disabling workplace injuries lead to the worst outcomes for workers and impose the highest cost on employers, making them an important priority for safety interventions. However, relatively little is known about how workplace disability rates of public safety employees compare with those of non-safety personnel. To study this issue in greater depth, we used data from a sample of public employees in California to examine the rate at which public safety employees claim permanent partial disability (PPD) benefits in the state's workers' compensation system compared with non-safety employees. PPD benefits are paid in the workers' compensation system for workplace injuries that leave someone with a residual disability that limits their ability to work. The data we used indicate that public safety employees are more than three times as likely to experience a permanent disability resulting from a workplace injury than are other public sector workers in non-safety positions.

We also found that disability rates differed by occupation and age. Figure S.1 compares the rate at which public safety and non-safety employees in our sample with workplace injuries filed for PPD benefits. The percentages of injuries involving permanent disability are reported by occupation for four different age categories: less than 40, 40–50, 50–60, and 60 and over. The figure indicates a clear difference in the age-disability profile for public safety employees relative to other public employees. For both police officers and firefighters, the likelihood that they receive PPD is increasing between each age category. PPD receipt increases from 39.5 percent for police officers under 40 to 62.5 percent for police officers 60 and over. Similarly, 30.9 percent of injured firefighters under 40 receive PPD, compared with 50.0 percent of injured firefighters 60 and over. However, injured public employees in other occupations display no clear pattern across age groups. Assuming no differences in claiming behavior, these results indicate either that older public safety employees experience more severe injuries, or that the injuries they experience for a given severity level are more likely to disrupt their ability to work.

Figure S.1.
Percentage of Injured Workers Receiving Permanent Disability Benefits, by Occupation and Age at Injury



RAND MG792-S.1

Policy Implications

The goal of this study was to characterize the health and safety risks to public safety employees in such a way as to help identify the most promising areas for reform that would both protect employees and help alleviate the costs of disability and injury compensation. While our analysis was never intended to design or evaluate any specific interventions, our findings offer several insights for policymakers at the state and local levels who are interested in implementing a program to reduce injuries or illnesses for public safety personnel.

A persistent theme in our findings was the need for better surveillance of injury data, particularly for injuries to law enforcement and emergency medical personnel. Improved data could help researchers identify the root causes for different types of public safety employees engaged in different activities, allowing for more efficient targeting of intervention strategies. Similarly, improved monitoring of the

types of situations and injury causes that lead to the most severe and disabling injuries would allow for the design of interventions to specifically reduce the most devastating injuries. It could also help monitor possible abuse of the system, for example, by tracking anomalies in the rates of disability retirement that do not appear to correspond to any perceptible change in the rates of injury known to lead to disability.

Several other issues emerged in our analysis and roundtable discussions that are potentially fruitful areas for safety intervention. Proper training is potentially a very strong tool for improving safety, although it can be both time-consuming and expensive. Other potentially promising targets include increased information analysis and sharing, strong safety messages from department leadership, and improvements to protective equipment.

One goal of our analysis was to examine how existing safety intervention priorities match up with the risks that safety employees are exposed to. We found that safety intervention efforts were strongly oriented toward fatality risks, with a particular focus on reducing heart attacks among firefighters. Our analyses using national survey data found that safety employees are more likely to be obese and might be more likely to experience heart disease, though this second finding was not robust. More work is needed to establish the extent to which the heart attack risk for firefighters and police officers is truly elevated over other occupations in a causal manner due to job-related conditions. Such information would help establish the extent to which current interventions and compensation mechanisms are appropriately targeted.

Another important priority among police officers and firefighters is reducing strains, sprains, and musculoskeletal disorders, which are by far the leading cause of nonfatal injuries. Unfortunately, it is not clear whether existing efforts, which focus largely on reducing heart attack risk and fatal injuries, will have a noticeable effect. More detailed examination of the effectiveness of different interventions would improve the ability to select and implement appropriate programs and reduce injuries.

Reducing the number of strains and sprains could potentially reduce the number of disability retirements among safety employees.

We found that both firefighters and police officers become more susceptible to work-related disability as they age, in the sense that a workplace injury is more likely to result in a permanent disability at older ages. This was especially true for firefighters. These findings suggest that policies that help prevent injuries or mitigate the adverse impacts of injuries on the ability to work among older public safety employees could also help reduce disability retirement rates.

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Abbreviations

BLS	U.S. Bureau of Labor Statistics
BMI	body mass index
CalPERS	California Public Employee Retirement System
CDC	Centers for Disease Control and Prevention
CHP	California Highway Patrol
CHSWC	California Commission on Health and Safety and Workers' Compensation
CPS	Current Population Survey
CVD	cardiovascular disease
EMS	emergency medical service
EMT	emergency medical technician
IACP	International Association of Chiefs of Police
IAFC	International Association of Fire Chiefs
IAFF	International Association of Fire Fighters
NFPA	National Fire Protection Association
NHIS	National Health Interview Survey
NIOSH	National Institute for Occupational Safety and Health

NLEOMF	National Law Enforcement Officers Memorial Fund
POST	California Commission on Peace Officer Standards and Training
PPD	permanent partial disability
PTD	permanent total disability
SCBA	self-contained breathing apparatus
TTD	temporary total disability
USFA	U.S. Fire Administration

Introduction

1.1 Background and Research Goals

Public safety employees are routinely asked to put their own lives and well-being at risk in order to protect the life and property of ordinary citizens. As a result, they face a substantially elevated risk of experiencing a workplace injury or fatality. Using data from a number of sources, Houser et al. (2004) report that, as of 2000, approximately 88,000 paid firefighters and 100,000 police officers experience occupational injuries or illnesses each year. Moreover, from 1999 through 2001 (excluding the 9/11 terrorist attacks) an average of 97 firefighters and 155 police officers are killed on the job annually. These translate into injury and fatality rates equal to approximately three times those that workers in non-safety occupation face, on average.

These high levels of risk have motivated considerable efforts by policymakers and researchers to identify the nature and causes of occupational health risks to public safety personnel, in order to better understand how to take steps to reduce them. Much of this effort has centered on identifying and mitigating fatality risks. While a focus on fatalities is certainly understandable given the enormous stakes involved for workers, the numbers cited above clearly indicate that reducing injuries and illnesses is also an important policy goal. This is particularly true of policies designed to lower the employer costs associated with occupational hazards, which are dominated by injuries.

More generally, efforts to improve the health and safety of public safety employees could benefit from a more complete understanding of the adverse consequences for worker health associated with different

aspects of public safety occupations. For instance, if certain types of injuries or illnesses were known to result from equipment limitations, then a reasonable intervention might focus on engineering solutions. Other injuries or illnesses may result from inadequate enforcement of particular policies, in which case the appropriate intervention could be quite different.

The objective of this study, which was funded by both the California Commission on Health and Safety and Workers' Compensation (CHSWC) and the National Institute for Occupational Safety and Health (NIOSH), is to examine the causes and consequences of workplace injuries to public safety employees, and to outline the implications for policies designed to protect them. To do so, we pursued the following research goals:

- Summarize the existing literature on the injury and fatality risks to public safety employees.
- Characterize the perceived risks and efforts currently used by public safety departments to reduce those risks.
- Describe the differences in the rates of injury, disability, and other chronic health problems for workers in public safety occupations compared with workers in other occupations.

To accomplish our research objectives, we combined detailed literature reviews, new data analyses, and the results of focused roundtable discussions with public safety workers to provide a broad overview of the opportunities and challenges that policymakers and employers face in improving the workplace safety of public safety employees. Much of our focus is on California, but we believe that many of the lessons learned from this report will be applicable to other states.

A central goal of our analysis is to identify the special health risks that public safety employees are exposed to by comparing their rates of work-related disability and chronic health problems with those of workers in other occupations. However, such comparisons come with potential pitfalls. The problem is that the reporting of work-related injuries, illnesses, and even fatalities can sometimes be biased by institutional factors related to the compensation mechanisms in place. More pre-

cisely, the definitions of what constitutes a work-related injury or illness, and a worker's incentives to report it, can sometimes be influenced by the compensation mechanisms in place. Public safety employees often have special compensation packages in place for work-related injuries, so interpreting data on their injuries and comparing them with those of non-safety employees can be particularly challenging.

The frequency of job-related heart disease among firefighters provides a perfect example of this problem. As we shall discuss later in the report, the leading cause of occupational fatality among firefighters is heart disease. This is typically attributed to such factors as work-related stress and exposure to smoke and other harmful materials, and as a result there has been considerable effort to reduce the rate of heart disease among firefighters. However, unlike non-safety occupations, heart disease is often presumed to be job-related for firefighters. This makes it extremely difficult to compare their rates of occupational heart disease with those the rest of the population, and to verify, using surveillance data, whether or not firefighters truly face an elevated risk of heart disease.

These kinds of reporting incentives driven by compensation mechanisms pose a considerable challenge for evaluating the relationships between work and health for public safety employees. This can be problematic when these observed relationships drive policy considerations. For instance, as we stated above, much of the current focus on improving firefighter health is dominated by reducing the risk of heart disease. If the elevated levels of reported job-related heart disease are not actually a causal result of workplace hazards or exposure, then these efforts might miss the opportunity to target other job-related health risks that have a greater impact on health.

We use two approaches to overcome the reporting pitfalls in our data analysis. First, we ignore the job-related distinction and compare the rates of certain chronic health conditions in the public safety and non-safety populations while controlling for other demographic characteristics. Because these analyses are conducted using national survey data and response is presumably unrelated to injury compensation, we expect to obtain unbiased measures of disease prevalence. Our second approach is to study job-related disability prevalence in administrative

data from the California workers' compensation system, but to focus on disability claims in which the eligibility requirements and reporting incentives are largely the same between public safety and non-safety personnel.

We feel that these approaches allow us to make meaningful comparisons in different health outcomes for public safety and non-safety personnel. However, it is important to note that with neither approach do we attempt to identify a truly causal effect of public safety work on health. Our analyses are simply intended to provide a clear picture as to how the health outcomes differ for public safety employees, and to draw out the implications that these differences have for public policy.

1.2 Defining the Study Population

Before moving on to the body of our work, it is worthwhile to take a moment to consider exactly what we mean by a “public safety employee.” In principle, there are many different occupations that involve promoting public safety in one form or another. Law enforcement and fire-fighting are the two largest and most obvious groups, but emergency medical service (EMS) responders, correctional facility officers, parole officers, and lifeguards are all occupations that address important safety needs. All of these occupations have considerable variation in the activities they perform, making it nearly impossible to characterize a uniform set of job hazards faced by public safety employees.

Even within the broad occupational categories, there can be considerable heterogeneity in the scope of activities that individuals perform and the work-related hazards these entail. Often, firefighters serve as EMS responders, so the risks they face at any given point in time depend on exactly which duties they are engaged in. Similarly, police officers will face different hazards if they are engaged in patrolling, detective work, or some form of special duty, such as a special weapons and tactics (SWAT) unit.

Unfortunately, the data we use in this report are generally insufficient to capture all of the relevant variation across occupations. We were usually, though not always, able to separately identify police offi-

cers and (career) firefighters, and so these are the occupations that constitute our primary focus. When data or other sources of information were available, we also considered EMS responders and corrections officers. For simplicity of exposition, we will often use terms such as “public safety employees” to refer to these workers as a class.

1.3 Organization of This Report

This report proceeds as follows. The next chapter provides a brief description of the injury compensation mechanisms for public safety employees and how they differ. This discussion provides both a broad overview of benefits nationally and a particular focus on California, which is relevant for some of the data we use.

Chapter Three provides a summary of the current literature describing the injuries, illnesses and adverse health outcomes that are associated with public safety employees. Much of the chapter focuses on professional firefighting occupations, because these occupations typically have the best data on injuries and illnesses. The literature review helps characterize the adverse health outcomes that appear to be the most common among public safety employees, and thus provide likely target points for designing interventions to improve safety.

Chapter Four discusses the findings from a series of focused roundtable discussions with public safety workers in California. The purpose of these discussions was to gain an enhanced understanding of the perceptions that individual departments hold about the priorities for improving the health and safety of workers. Questions that were addressed include the types of activities most associated with injuries, the types of activities (if any) currently being used to improve safety, and perceived operational challenges to implementing interventions. These panel discussion findings are compared with the injury and health data from the literature review to determine how safety and health improvement interventions align with safety and health risks.

Chapter Five uses nationally representative survey data to provide new evidence about adverse health outcomes experienced by police officers and firefighters. This analysis compares the rates of work-related

injury, workers' compensation claims, and self-reports of disability and certain health conditions of public safety employees among individuals in different occupations. Additionally, it compares behavioral risk factors for poor health across the different occupations.

In Chapter Six, we examine the job-related disability rates that are reported by public safety employees and compare them with those of non-safety employees. The chapter uses administrative data from California, and compares the rate at which public safety employees claim permanent disability benefits. We compare disability rates by occupation and age, to identify the groups that appear most susceptible to disabling injury. This chapter also provides a brief discussion of the incentive effects of increased injury compensation, and the implications for safety interventions.

In Chapter Seven, we conclude by interpreting our different findings in light of one another, with a focus on drawing out the policy implications of our work.

Description of Injury and Disability Compensation for Public Safety Employees

Public safety employees often have injury and disability compensation programs that differ from those available to the general public. These differences are important to keep in mind when making comparisons in reported disability or injury rates between public safety and non-safety personnel. The level of compensation can affect workers' incentives to report injuries and file for benefits, possibly influencing surveillance data on injuries. Similarly, differences in which conditions are considered occupational or job-related between public safety and non-safety employees could generate differences in injury or illness rates. Compensation mechanisms could also influence the value of safety interventions, because they potentially affect the employer cost of injuries (and thus the benefits that employers gain from successfully preventing injuries). This chapter summarizes the various injury-related compensation packages available to public safety and non-safety personnel, with a particular focus on California (which is relevant for the data we study).

2.1 Workers' Compensation Benefits

When an individual suffers an occupational injury or illness in the United States, the most common form of compensation available to him or her is through a state workers' compensation system. Through workers' compensation, employers are required to pay insurance ben-

efits to injured workers. There is significant variation in the design of state programs, but there are some similarities in the kinds of benefits available to workers. Typically, employers are required to compensate injured workers for all medical expenses (medical benefits), and replace some fraction of lost wages (indemnity benefits).

Indemnity benefits vary depending on whether the injury is permanent or temporary. Generally, there are four types of indemnity benefits: temporary total disability (TTD) benefits, permanent partial disability (PPD) benefits, permanent total disability (PTD) benefits, and fatality benefits. Most attention is typically paid to TTD and PPD benefits because they are more common by far.

The indemnity benefits available to public employees often differ from those available to private employees, and the benefits available to public safety employees differ even more. The benefits often differ for both temporary and permanent disabilities. First consider temporary disability benefits. Most state workers' compensation programs provide weekly TTD benefits that are equal to two-thirds of pre-injury weekly earnings, subject to a cap (e.g., two-thirds of weekly wages up to \$500 per week). Workers' compensation benefits are tax-free at the state and local level, though some states (such as Ohio) set benefits as a fixed fraction of after-tax earnings.

Many public employees receive negotiated benefits called salary continuance, which replaces a higher portion of wages for some limited period of time after an injury. There is no set formula for salary continuance, but a common example would be a worker receiving 80 percent of his or her pre-injury salary for the duration of the injury. In principle, salary continuance can be negotiated for private employees as well, though anecdotal evidence suggests that it is more common for public employees (perhaps due to the higher rates of unionization among public employees).

Public safety employees are sometimes given higher temporary benefits as a result of legislative action. In California, Labor Code 4850 provides police officers, firefighters, and other designated public safety employees with their full salary, tax-free, for up to one year following a work-related injury. A survey conducted by RAND in 2000 found that this provision is far from unique, with about 20 percent of states

and more than half of large, urban municipal departments across the country offering similar provisions to police officers and firefighters (Reville and Seabury, 2000). Sometimes the benefits are provisional on an injury that is related to a particular aspect of work; for example, some states only provide the additional benefits to a police officer injured by assault or a firefighter injured on the fireground.

Public safety employees are not necessarily the only public workers offered special benefits. While less generous, public school teachers in California are also granted special benefits; Section 44984 of the California Education Code requires that any certificated employee injured at work be given his or her full salary, tax-free, for 60 work-days (Cal. Ed. Code § 44984(d)).¹ We are unaware of whether there are similar provisions for teachers in other states besides California, though a handful of municipalities surveyed by RAND found that all city workers received special temporary benefit provisions (Reville and Seabury, 2000).

As indicated in the introduction, public safety employees also differ in the types of illnesses for which compensation may be available. For most occupations and illnesses, the burden is on the employee to prove that an illness is job-related. However, public safety employees often receive special presumptions under the law that specified diseases are job-related—meaning the employer must prove that they are not job-related to deny compensation. The RAND survey found that, for firefighters, 32 states presumed heart disease to be job-related, 30 presumed respiratory diseases to be job-related, and 19 presumed that certain cancers were job-related. For police officers, 21 presumed heart disease to be job-related, 13 presumed respiratory disease to be job-related, and 2 presumed certain cancers to be job-related (Reville and Seabury, 2000). California has presumptions for all three types of diseases for both police officers and firefighters.

Permanent partial disabilities are typically compensated much differently than are temporary disabilities. Generally, in state systems

¹ The term “certificated employee” refers to someone who is employed in a position that requires a certificate of qualifications but who is not necessarily a teacher (Cal Ed. Code § 1294).

there are three key steps to determining PPD benefits: establishing that a disability exists, evaluating the severity of a disability, and assigning compensation based on severity. States vary considerably in how they operationalize each of these steps, and a full accounting of the different approaches used is beyond the scope of this report. For our purposes, it is enough to note that the presence of a disability is usually established with a medical-legal report performed by a physician, often based on an impairment rating guide, such as the American Medical Association's *Guides to the Evaluation of Permanent Impairment* (American Medical Association, 2000). Benefits are then set either based on the nature and/or severity of the injury established in the report, or as a function of the wage losses experienced by the worker (for more detail, see Berkowitz and Burton, 1987, or Reville et al., 2005). PPD benefits in most states are typically much less than TTD benefits, but are often available as a lump sum (representing a settlement between workers and employers to cover future liabilities) instead of as a weekly benefit.

Later in the report, we use California state data on PPD claims from public safety employees and non-safety public employees injured in the early 1990s. For that reason, we offer a little more detail on California's PPD system. In the early 1990s, California scheduled PPD benefits based on a disability rating system, a quantitative (scale of 1 to 100) measure of disability severity, with more severe disabilities earning higher benefits. Also during this period, the benefits were not tied to labor market participation after the injury (i.e., benefits were the same whether or not the injured worker returned to work). The disability rating schedule in place at this time was unique to California (the state has since switched to using the AMA *Guides*), and highly controversial because of its alleged reliance on subjective (on the part of the physician) criteria (Reville et al., 2005). Importantly for the analysis in this report, neither the disability benefits nor the physician ratings differ between public safety and non-safety personnel. That is, a police officer and a clerical worker that had the same rating would be entitled to the same benefits.

2.2 Disability Retirement Benefits

While PPD benefits are usually the only form of compensation for permanent disabilities available to private employees, public employees are much more likely to have access to pension benefits that offer additional compensation in the event of a permanent disability. Such pension benefits do not replace permanent disability benefits, but they can offer additional compensation that is unavailable to many private employees.² As with the temporary disability benefits, the disability retirement benefits provided to public employees differ for public safety and other, non-safety employees.

The variation in disability retirement programs across different states varies even more than permanent disability compensation. In fact, often the benefits available will vary within a state. A full characterization of the disability retirement benefits available through public pensions in the United States is a project all on its own. Here, we provide a brief summary of benefits available in the California Public Employee Retirement System (CalPERS). CalPERS is a large public pension system that provides a variety of different medical and retirement benefits to a majority of public employees in California, benefits which vary depending on the employee class and date of employment. We focus on CalPERS because our later analysis uses data on members of the system, though it is not the only source of retirement benefits in the state (for example, while most cities are CalPERS members, most counties have their own pension systems).

Most retirements in CalPERS are standard service retirements, with benefits equal to a set function of earnings at the time of retirement and the number of years of service. Virtually no employees can receive a service retirement before age 50, but public safety employees often accrue benefits faster than other public employees, so their ben-

² As was the case with salary continuance, nothing prevents private employees from negotiating pension benefits that mimic those given to public employees. To our knowledge, such private sector pensions are far less common than in the public sector. However, private employees sometimes have the option of purchasing short-term or long-term disability insurance, which may supplement PPD benefits.

efits often max out at younger ages. Thus, public safety employees are much more likely to retire in their 50s as opposed to their 60s.

There are two types of disability retirement benefits that are available to public employees: industrial disability benefits and ordinary disability benefits. Industrial disability retirements are available primarily to public safety workers. Industrial disability retirement benefits are provided to eligible employees who suffer a work-related disability, and are equal to 50 percent of salary. Other disability retirements, also called ordinary disability, are available to employees who become disabled and unable to work, whether or not it is due to a workplace injury or illness. Ordinary disability benefits are a function of tenure at the time of disability, but cannot exceed 33.33 percent of the injured workers salary. Additionally, there is a five-year vesting requirement for an ordinary disability retirement. Clearly, the disability retirement benefits available to public safety employees are considerably more generous than those for workers in other occupations.

It is worth pointing out that there is not a direct link between PPD claims and disability retirement in CalPERS. That is, it is not necessary that a worker file for PPD benefits to claim disability retirement benefits. Nor is it necessarily the case that someone who receives PPD benefits will be eligible for disability retirement. The medical review process for disability retirement is different than the disability evaluation process for PPD benefits.³

It is difficult to put CalPERS benefits in the context of the “average” disability retirement system, because we are not sure that such a thing exists. The general differences between public safety and non-safety employees in the CalPERS system—the ability to retire at younger ages, enhanced eligibility and benefits for disability retirements—appear to be common in many other state retirement systems. However, we would not make the claim that the benefits in California are necessarily representative.

A final important feature of industrial disability retirements is their treatment under the federal tax code. Under Internal Revenue

³ For more information on CalPERS retirement benefits, including the medical review process for disability retirement, see the CalPERS Web site (CalPERS, 2008).

Code Section 104(a)(1), service-related disability retirement benefit amounts that are 50 percent or less than pre-retirement income are nontaxable (anything above 50 percent is taxed like normal income). An exception to this is income that comes from disability retirement based solely on a presumption of job-relatedness for a disabling illness (e.g., heart disease). In these cases, the benefits are taxable. This suggests that, in many cases, the after-tax industrial disability benefits for workers can be considerably higher than 50 percent. It also suggests that if a worker's marginal tax rate were high enough, he or she could actually receive higher net pay with a disability retirement than with an ordinary service retirement.

What Is Known About the Safety and Health of Public Safety Employees?

This chapter summarizes the existing literature on the safety and health risks faced by public safety employees. The objectives of this review are to (1) characterize the frequency, cause, and type of injuries and fatalities suffered by public safety workers and (2) summarize what is known about the health outcomes of public safety workers and, where possible, ascertain the extent to which these health outcomes are work-related. These findings provide the basis for interpreting the findings on safety and health interventions discussed in Chapter Three and also complement the disability and health outcome analyses in Chapter Four.

3.1 Methods and Data Sources

This review was compiled from two general types of data sources: national surveillance data collected for public safety workers and empirical studies examining the occurrence of specific health conditions among public safety workers.

Surveillance Data

Public safety organizations maintain surveillance systems for tracking and characterizing worker fatalities, injuries, and illnesses. Multiple systems are maintained by different organizations, and the classification criteria and content of the different datasets vary. The most information is available for fatalities. Less information is available on injuries, and

very little is available on illnesses. In terms of the workforce, by far the most data are available for the fire service, with far less data available for law enforcement services. Data for EMS workers are usually combined with fire service data. In addition, there is substantial overlap between the populations in the two services, as many EMS responders are also firefighters (Houser et al., 2004).¹ Few data are therefore available explicitly for safety and health in the emergency medical service. A similar situation exists for corrections officers, for whom safety and health data are sometimes combined with data for police and sheriff departments under the general heading of law enforcement.

Empirical Studies

In addition to surveillance data, we reviewed empirical studies examining health outcomes for public safety workers. Some of these studies compare health outcomes of public safety workers with those of the working or adult population in the United States. Some also examine the extent to which certain health outcomes are work-related. The number of relevant studies is small, and the quality is quite variable. The studies use several different approaches and, not surprisingly, the findings do not always agree. We did not use specific criteria for selecting studies to include in our review (i.e., we did not conduct a meta-analysis). Rather, we present an overview of available data and draw general conclusions from them.

3.2 The Fire Service

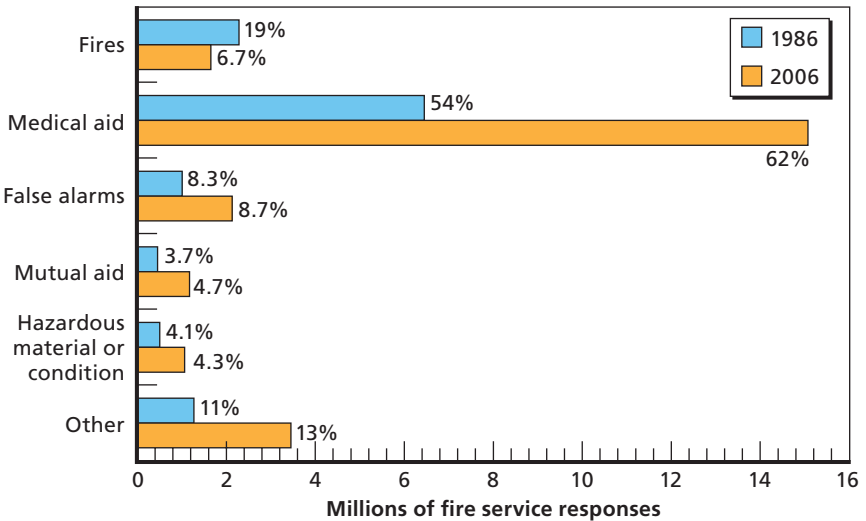
There are approximately 1.1 million firefighters working in about 30,000 fire departments in the United States (Karter, 2006). These numbers include only municipal firefighters and exclude part-time paid firefighters and firefighters and departments in state and federal agencies and private companies. Only about 28 percent of municipal firefighters are paid (paid municipal firefighters are often referred to

¹ Emergency medical service is provided by the fire service in more than half of fire departments in the country (Karter, 2006).

as “career” firefighters), with the remaining 72 percent acting as volunteers (Karter 2006). Volunteer fire departments are most common in smaller towns and rural areas, with the proportion of career departments increasing with the size of the protected population. Figure 3.1 presents a summary of the main types of emergency calls that the fire service responds to. The figure shows the distribution of different types of responses in the fire service and how that distribution has changed since 1986. The most common type of response is for emergency medical service, which accounted for more than 60 percent of fire service calls in 2006. Since 1986, the proportion of fire responses has dropped substantially while the proportions of all other call types has increased. The drop in fire calls is generally attributed to improved fire-prevention efforts.

Firefighters face a wide array of safety and health hazards, including physical stress and overexertion, vehicle crashes, burns, inhalation of smoke and toxins, asphyxiation, and blunt trauma, as well as more

Figure 3.1
Distribution of Fire Service Calls in 1986 and 2006



SOURCE: NFPA (2008).
NOTE: Percentages show fraction of total repsonses that year.
RAND MG792-3.1

general occupational hazards, such as heavy lifting and slips and falls (LaTourrette et al., 2003; Karter, 2007; Bogucki and Rabinowitz, 2004). These hazards lead to a wide variety of fatalities, injuries, and illnesses.

In addition to responding to emergency calls, official fire service responsibilities include training, maintenance, public education, inspection, investigations, court testimony, and fundraising. In addition, career firefighters, who generally work 24-hour shifts out of a station house, are on duty at all times while on call during their shifts (USFA, 2008c).

The unusual shift schedule, wide range of work activities, and wide range of occupational hazards in the fire service has implications for characterizing and interpreting occupational injuries and illnesses. One is that, as discussed in more detail below, firefighters spend a relatively small fraction of their time on high-risk emergency response duties. Aggregate injury statistics therefore mask the higher injury rates during these activities.

A second implication is that assessing the work-relatedness of injuries and illnesses, which is rarely clear-cut in any occupation, is sometimes more complicated in the fire service. Although the work-relatedness of acute injuries is rarely a question, difficulties arise in assessing the origin of some chronic conditions. The most prominent example of this is heart disease. Heart disease, several forms of cancer, and a host of other health conditions are legislatively presumed to be work-related for firefighters in California and several other states. This means that on-duty heart attacks are always counted as work-related deaths for firefighters. This is not the case for most other occupations. In fact, the U.S. Bureau of Labor Statistics (BLS) does not include heart attacks in its occupational fatality estimates. Given that, as discussed below, heart attacks account for nearly half of all on-duty firefighter deaths, the perspective on occupational fatalities and safety and health interventions in the fire service is dominated by a factor that is rarely even considered in other occupations.

Fire Service Fatalities

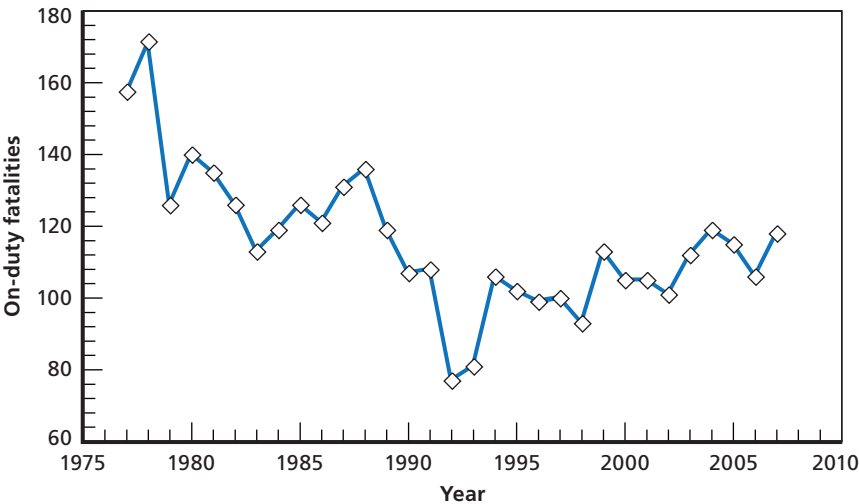
A number of different national surveys gather information on firefighter fatalities, including the National Fire Protection Association's (NFPA's) Annual Fire Experience Survey, annual analyses by the U.S. Fire Administration (USFA), the National Fallen Firefighter Memorial Database, and BLS's Census of Fatal Occupational Injuries. Although there are differences in details among these different sources, the data are generally consistent in terms of the numbers and causes of firefighter fatalities in the United States.

From 2001 to 2007, there were an average of 111 on-duty firefighter fatalities per year (USFA, 2008b). Approximately 41 percent of these deaths were paid firefighters, including career (full-time municipal) and otherwise paid (part-time, state, federal, or private) firefighters. The remaining 59 percent were volunteers (USFA, 2008b). These fatalities include any injury or illness sustained while on duty that proves fatal. "On-duty" covers all officially assigned duties, including emergency and nonemergency activities (USFA, 2008c).² Since 1977 there has been an average decrease in firefighter fatalities of about 1.1 percent per year, although the trend appears to have flattened in recent years (Figure 3.2).

Fatality rates for firefighters are uncertain because of differences in how different organizations record numbers of firefighters and numbers of firefighter fatalities. Estimates of the average fatality rate from 2001 to 2006 derived from different sources are shown in Table 3.1. The convention in reporting occupational fatality rates is to report the number of fatalities per 100,000 workers, regardless of the amount of time they work (BLS, 2008a). Most volunteer firefighters work part-time, sometimes as little as a few hours per year, so fatality rates for volunteers do not provide a good measure of the fatality risk of firefighting as an occupation. Because of this, volunteer firefighters, who make up about two-thirds of all firefighters, are excluded from the estimates in

² Under certain conditions, deaths that occur off-duty are included in the on-duty fatality counts. Serious on-duty injuries, such as physical trauma, that lead to subsequent death off-duty are included. In addition, off-duty heart attacks and strokes are included if the firefighter was engaged in non-routine stressful or strenuous physical activity while on duty and became ill within 24 hours of engaging in such activity (USFA, 2008c).

Figure 3.2
Trend in Annual On-Duty Firefighter Fatalities, 1977–2007



SOURCE: USFA (2008b, 2008c).
NOTE: Excludes fatalities from the 9/11 terrorist attacks.
RAND MG792-3.2

Table 3.1
Average Annual On-Duty Firefighter Fatality Rates, 2001–2006

Estimate	Average Annual Fatalities	Average Annual Worker Population	Average Annual Fatality Rate per 100,000 Workers
Including Heart Attacks and Strokes			
USFA career firefighters	44	302,917	14.1
NFPA career firefighters	28	302,917	8.7
Excluding Heart Attacks and Strokes			
USFA career firefighters	26	302,917	8.3
NFPA career firefighters	14	302,917	5.0
U.S. workforce	5,727	140.3 million	4.0

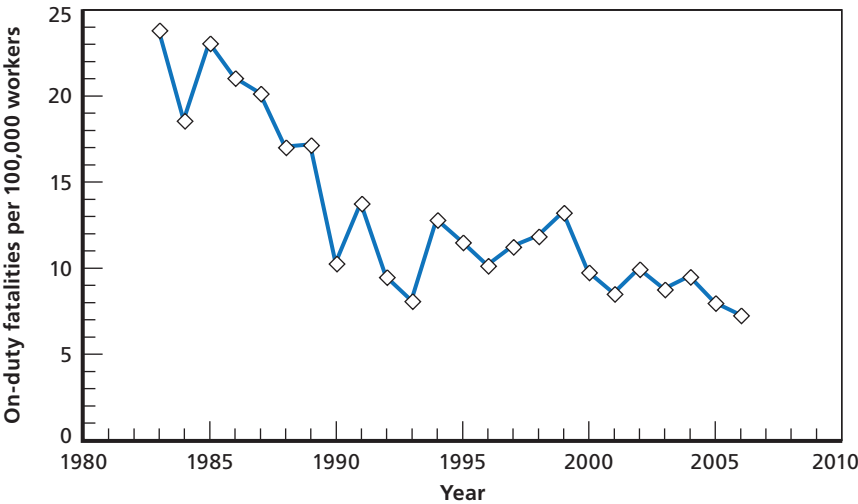
SOURCES: USFA fatality estimates from USFA (2008b). NFPA fatality estimates from Fahey, LeBlanc, and Molis (2006). Firefighter population from Karter (2006). Estimates for the U.S. workforce from BLS (2008a).
NOTES: Firefighter fatalities and population are for career (full-time municipal) firefighters. Average annual fatality rate is the average of the fatality rates from each year.

Table 3.1. The BLS does not consider heart attacks and strokes to be occupational injuries and so does not include them in their Census of Fatal Occupational Injuries. Therefore, in order to facilitate comparison with the national workforce, Table 3.1 also shows fatality rate estimates that exclude heart attacks and strokes. When including heart attacks and strokes, estimates of firefighter fatality rates range from 9 to 14 fatalities per 100,000 workers. Excluding heart attacks and strokes decreases fatality rate estimates considerably, with the maximum value being 2.1 times the national average of 4.0 fatalities per 100,000 workers.

The historical trend in NFPA firefighter fatality rate is shown in Figure 3.3. The trend shows a marked decrease of more than a factor of two since 1983.

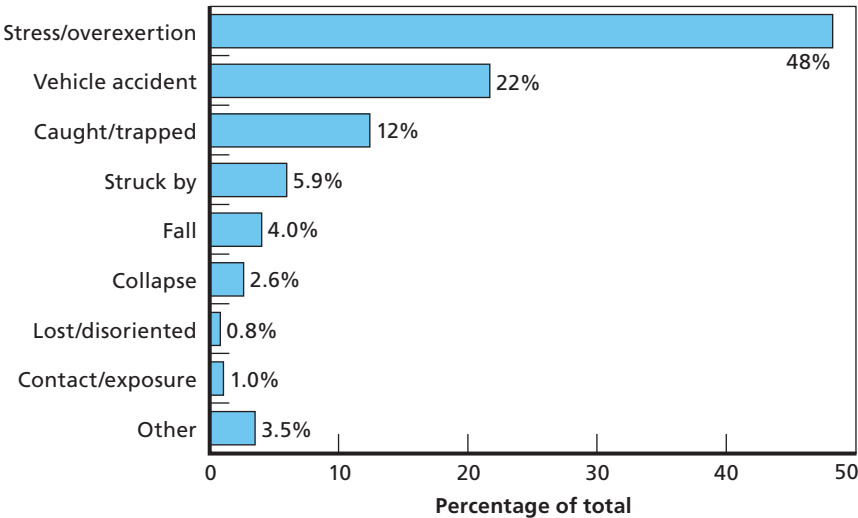
Firefighter fatalities from 2001 to 2007 are distinguished according the cause of the fatal injury in Figure 3.4. The most common cause is “stress of overexertion” (48 percent), which includes fatalities resulting from heart attacks (46 percent) and strokes or aneurysms (2 per-

Figure 3.3
Trend in Annual On-Duty Fatality Rates for Career Firefighters, 1983–2006



SOURCE: Karter (2006); Fahey, LeBlanc, and Molis (2008).
NOTE: Excludes fatalities from the 9/11 terrorist attacks.

Figure 3.4
Cause of On-Duty Fatal Firefighter Injuries, 2001–2007



SOURCE: USFA (2008b).

RAND MG792-3.4

cent). Nearly half of all on-duty firefighter deaths have resulted from heart attacks since at least the 1970s (USFA 2002, 2008b; Centers for Disease Control and Prevention [CDC], 2006; Fahey, LeBlanc, and Molis, 2007). The fraction of fatalities that result from heart attacks has generally been higher for volunteers (about 50 percent) than for paid firefighters (about 40 percent) (CDC, 2006).

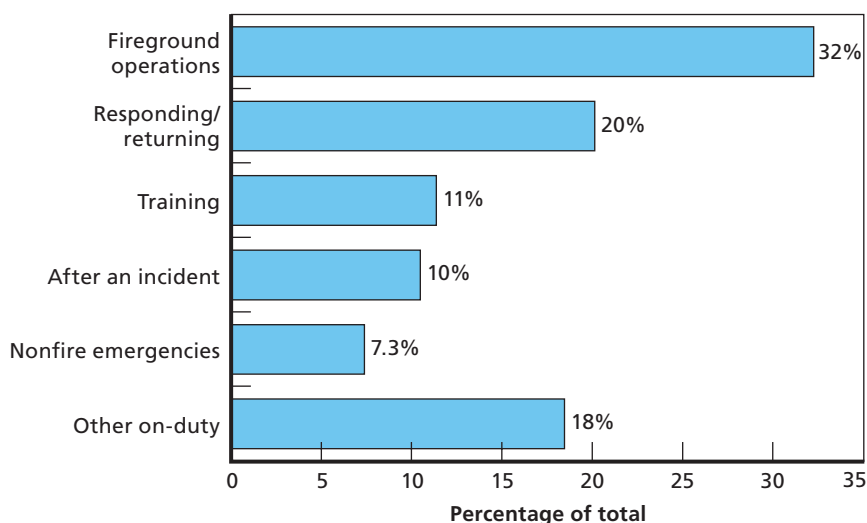
The next highest cause of firefighter fatalities is motor vehicle accidents, which accounted for 22 percent of the deaths from 2001 to 2007. Motor vehicle accidents have accounted for between 15 percent and 25 percent of firefighter fatalities per year since 1977 (USFA, 2002, 2008b; Fahey, LeBlanc, and Molis, 2007). From 2004 to 2006, about half (54 percent) of the firefighters killed in motor vehicle collisions were volunteers. Of these, 90 percent died in crashes involving personally owned vehicles or water tenders.³

³ Most volunteer departments allow personnel to respond from home or work in personally owned vehicles (which are smaller and less noticeable than fire apparatus). In addition,

The BLS reports data for fatal occupational injuries for all occupations. Although the BLS classifies workplace fatalities differently than does the USFA for firefighters, it is clear that the distribution of types of fatal injuries for firefighters is very different than that for U.S. workers in general. For example, BLS data from 2001 to 2005 show that workplace fatalities are dominated by transportation incidents (43 percent), contact with objects and equipment (17 percent), assaults and violent acts (15 percent), and falls (13 percent) (BLS, 2008a).

Figure 3.5 highlights the type of duty that firefighters were engaged in when they died. From 2001 to 2006, most fatalities (70 percent) were associated with emergency activities (the USFA categories associated with emergencies are “fireground operations,” “respond-

Figure 3.5
Firefighter Fatalities by Type of Duty, 2001–2007



SOURCE: USFA (2008b).

RAND MG792-3.5

the lack of fire hydrants in the rural areas served by volunteers requires them to drive water tenders (tanker trucks) to many fires, and these tenders are notoriously dangerous (USFA, 2002).

ing/returning,” “nonfire emergencies,” and “after an incident”⁴). Emergency activities account for only about 30 percent of firefighters’ time. Further, over 60 percent of emergency calls to fire departments are for emergency medical service (Figure 3.1), which are the source of only about 3 percent of fatalities (USFA, 2002). This indicates that 70 percent of firefighter fatalities are concentrated into the less than 20 percent of time spent on non-EMS-related emergencies. This illustrates that the fatality risks in firefighting vary substantially with the type of duty and thus that the overall casualty rates mask the extreme risks associated with certain emergency conditions. Kales et al. (2007) estimated that firefighting accounted for no more than 5 percent of work time in the fire service, yet nevertheless concluded that the risk of heart attack deaths during fire suppression was 10–100 times higher than for nonemergency duties.

Fire Service Injuries

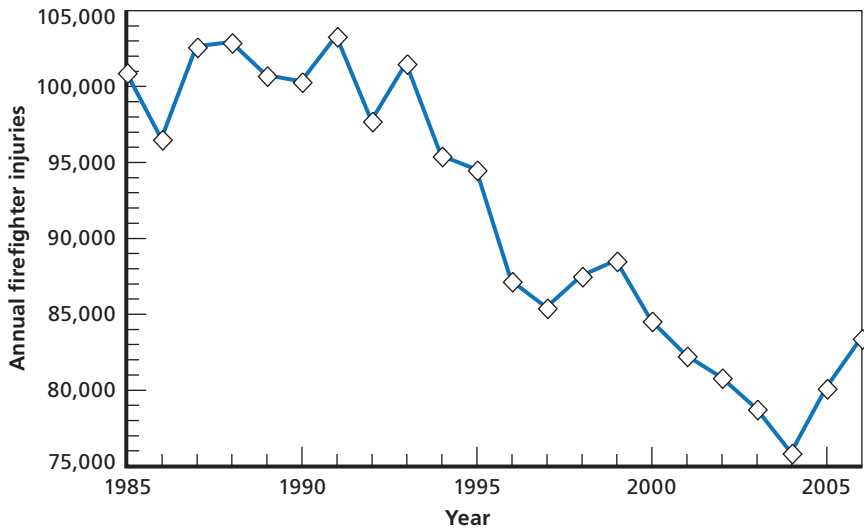
Firefighter injury data are collected by the NFPA through an annual survey. These data are shared with the USFA and published by both the NFPA and the USFA. These data do not distinguish injuries by severity. The NFPA survey questionnaire asks respondents to report all injuries that “require (or should require) treatment by a practitioner of medicine (physician, nurse, paramedic, EMT [emergency medical technician]) within one year of the incident (regardless of whether treatment was actually received), or result in at least one day of restricted activity immediately following the incident” (NFPA, 2006). This description indicates that, in the classification scheme conventionally used for workers’ compensation insurance, the injuries in these data include “medical only” and more severe injuries.

Approximately 83,000 firefighters were injured in 2006. Since 1985, the number of annual firefighter injuries has decreased about 1.5 percent per year (Figure 3.6).

Detailed data are available on the medical outcomes of injuries (often referred to as the “nature” of injury) and the general type of duty

⁴ “After an Incident” deaths consist mostly of heart attacks and are considered to be emergency incident-related.

Figure 3.6
Annual On-Duty Firefighter Injuries, 1985–2006



SOURCE: USFA (1997, 2004b, 2008a).

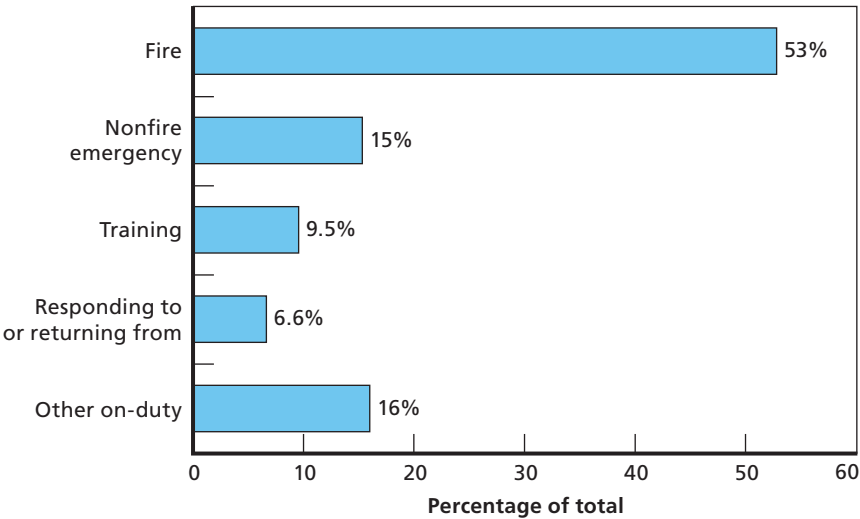
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firefighters were engaged in when injured. Data on the proximate cause of injury and on injury severity, on the other hand, are available for fireground injuries only, which, as described below, account for only about half of all injuries.

Figure 3.7 breaks down injuries from 2004 to 2006 by type of duty, and shows that about 50 percent of firefighter injuries occur on the fireground. This fraction has remained relatively constant since at least 1992 (USFA, 2004b, 2008a). When injuries at the fireground are combined with travel to and from the incident and nonfire emergencies, 75 percent of firefighter injuries occur during emergency operations. As was the case for fatalities, this is greater than the fraction of time spent on emergencies, indicating that firefighters are more likely to be hurt during emergency activities than during other types of work.

A standard hypothesis is that the decline in the injury rate of firefighters over time can be attributed primarily to a decrease in the number of fires. Figure 3.8 compares the annual change from 1985 by

Figure 3.7
Firefighter Injuries, by Type of Duty, 2004–2006

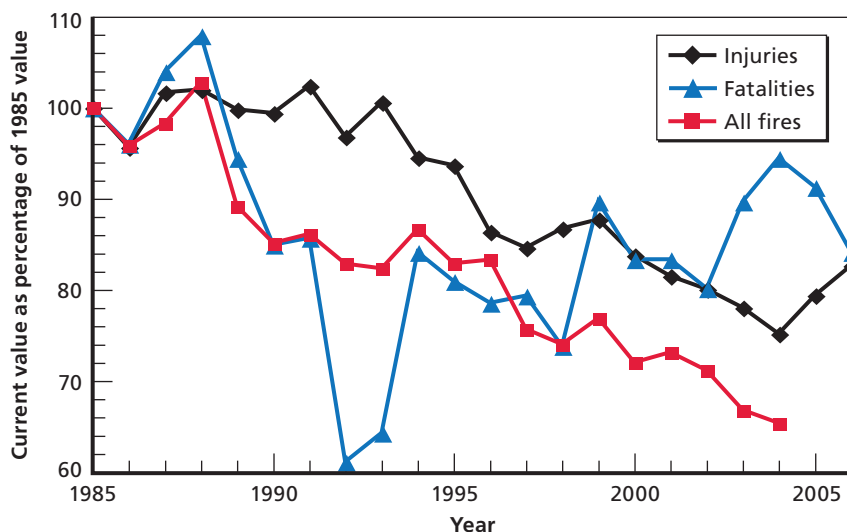


SOURCE: Karter and Molis (2005, 2006, 2007).

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year in the number of fatalities, injuries, and fires. So, for the line indicating fires, the vertical axis represents the number of fires in that year divided by the number of fires in 1985. The figure demonstrates that the numbers of annual fires and injuries have dropped by grossly comparable amounts since 1985. Note, however, that the trend in fatalities appears largely uncorrelated with the trend in fires.

The distribution of firefighter injury types is shown in Figure 3.9. Injuries are dominated by sprains and strains, followed by lacerations and bruises. Injuries directly related to exposure to fire and to combustion products (burns, smoke or gas inhalation, and thermal stress) together account for 15 percent of the injuries. Note that heart attacks and strokes, which account for 50 percent of fatalities, account for only 1 percent of nonfatal injuries. Out of the 2,803 on-duty heart attacks and strokes recorded from 2004 to 2006, 2,635 (94 percent) were nonfatal.

Figure 3.8**Decrease in Annual Firefighter Injuries and Fatalities and Fires from 1985 to 2005**

SOURCE: USFA (1997, 2004b, 2007b, 2008a, 2008c).

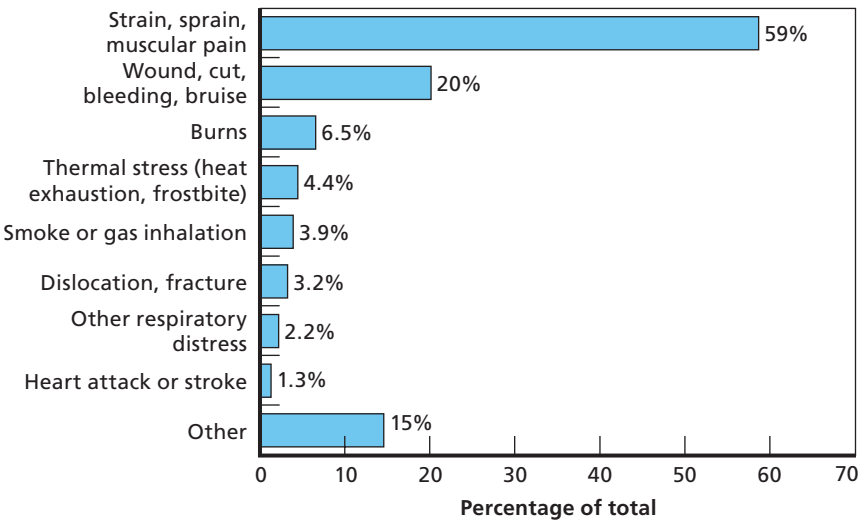
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Health Outcomes in Firefighters

In this section, we summarize the findings from empirical studies examining health outcomes among firefighter populations. These studies address a range of health outcomes, and many examine the extent to which health outcomes differ from other populations. In some cases, the studies also provide useful insights into the extent to which a particular health outcome may be work-related. We also include discussion of the risk factors associated with different conditions and the ways in which these risks are being addressed in the fire service. The study designs vary considerably, and we have not attempted to estimate the quality of the analyses or weight the results based on quality.

Musculoskeletal Disorders. The majority of on-duty firefighter injuries involve strains, sprains, dislocations, and fractures (Figure 3.9). Beyond general surveillance data, few studies have examined musculoskeletal disorders in firefighters, possibly because such conditions are common for the population in general and are not obviously more prev-

Figure 3.9
Nature of On-Duty Firefighter Nonfatal Injuries, 2004–2006



SOURCE: Karter and Molis (2005, 2006, 2007).

RAND MG792-3.9

alent among firefighters. A focus group study identified several individual, workplace, and environmental factors as contributing to musculoskeletal injuries among firefighters (Conrad et al., 1994). Strains and sprains dominate the medical costs for workers’ compensation claims (Walton et al., 2003), and back injuries are the most common cause of disability retirement for professional firefighters (International Association of Fire Fighters [IAFF], 2000).

Thermal Injuries. Thermal injuries account for about 10 percent of firefighter injuries, with burns and thermal stress accounting for about 6 and 4 percent, respectively (Figure 3.9). Burns also account for about 5 percent of firefighter deaths (USFA, 2008b). Firefighter thermal injuries are unequivocally work-related and result from direct exposure to fires as well as from overheating caused by engaging in intense physical activity while wearing heavy fire-resistant clothing (“turnout gear”). Although little information is available about the nature of thermal injuries, their prevalence and severity are strongly influenced by the

design and use of turnout gear. Advances in textile technologies, including greater flame resistance, increased heat and moisture dissipation, lighter weight, and more ergonomic designs, have led to a decrease in the incidence and severity of firefighter burn injuries without increasing the incidence of heat exhaustion or cardiac events (Prezant et al., 1999a, 2000, 2001; Rabbitts et al., 2005).

Cardiovascular Disease. As noted above, heart attacks and strokes consistently account for nearly half of all firefighter fatalities. A large number of studies have examined the incidence of cardiovascular disease (CVD) and associated risk factors in firefighters. Despite the fact that heart attacks have long been presumed to be work-related (to the point that heart attacks are legislatively presumed to be work-related for workers' compensation and disability purposes), evidence for an occupational association has been slow to emerge.

Part of the difficulty in making this connection is that CVD is a common cause of death for the general population, and the dominant factors observed to be associated with heart attacks among firefighters are not job-related and are the same as those for the general population. Relative to all firefighters, firefighters who suffer sudden cardiac death have significantly higher prevalence of several known risk factors, including being over the age of 45, current smoking, hypertension, and prior known coronary artery disease (Kales et al., 2003; NIOSH, 2007). In addition, firefighters are more likely than the general public to have a wide range of cardiovascular risk factors, including a high body mass index (BMI; see also Chapter Five), lower cardiovascular endurance, elevated total cholesterol, and hypertension (e.g., Horowitz and Montgomery, 1993; Byczek et al., 2004; Womack, Green, and Crouse, 2000). Thus, any occupational influence needs to be distinguished from these more general risk factors.

The relationship between CVD, heart attacks, and occupational risks is complex and beyond the scope of this review. We note some recent work suggesting that firefighter heart attacks may be work-precipitated. However, such an association does not necessarily mean that CVD in firefighters is work-related. In other words, while there may be evidence suggesting that firefighting may trigger heart attacks, these

heart attacks may have been inevitable and the underlying cause (i.e., cardiovascular disease) may be unrelated to firefighting work.

Work by Hales et al. in 1999 (as reported in NIOSH, 2007) first showed that the majority of fatal heart attacks for firefighters occurred in the afternoon or evening. This is in stark contrast to the general population, for which most heart attacks occur in the morning, and suggests that firefighter heart attacks may be work-related. Kales et al. (2003, 2007) have shown that the risk of sudden cardiac death during high stress and physically demanding firefighting activities is significantly higher than during nonemergency duties (up to more than 100 times higher for fire suppression), strongly supporting the assumption that on-duty heart attack fatalities are work-precipitated.

Further indications of the work-relatedness of heart attacks among firefighters are highlighted in a review by NIOSH (2007). These include an increased risk of CVD associated with exposure to carbon monoxide, hydrogen cyanide, and particulate matter, which are common components of fire smoke and apparatus exhaust; an association between heart attacks and activities that involve heavy physical exertion and cause heat stress; and an increased risk of hypertension (a risk factor for CVD) associated with noise exposure. In addition, the physiological and psychological effects of 24-hour work shifts, which are common in the fire service, lead to an increase in the prevalence of obesity and hypertension and increase the risk of CVD independent of other risk factors (Elliot and Kuehl, 2007; NIOSH, 2007).

Cancer. A number of studies have examined the incidence of cancer among firefighters. Overall cancer rates for male firefighters are not significantly higher than for the general population, but female firefighters have a significantly increased overall risk of cancer (Baris et al., 2001; Ma et al., 2006). In addition, findings indicate that occurrences of several specific cancer types are significantly higher among firefighters than the general population, although different studies do not always agree. Cancers identified as being more common among firefighters than the general public include bladder, testicular, ureter, kidney, brain, thyroid, esophageal, lung, colorectal, prostate, cervical, melanoma, lymphoma, multiple myeloma, and Hodgkin's disease

(Guidotti and Brandt-Rauf, 1995; Baris et al., 2001; Ma et al., 2006; Bates, 2007).

Firefighters are routinely exposed to a number of carcinogens during firefighting, such as benzene, polycyclic aromatic hydrocarbons, and soot (Jankovic et al., 1991; Austin et al., 2001a; Caux, O'Brien, and Viau, 2002; Reinhardt and Ottmar, 2004). In many cases, these compounds have been directly implicated in causing the cancers for which firefighters are observed to be at increased risk, supporting an occupational exposure origin (Golden, Markowitz, and Landrigan, 1995; Ma et al., 2006).

Respiratory Disorders. Firefighters are at risk for respiratory disorders because of their inhalational exposure to particulates and toxic compounds. The risk of respiratory problems is strongly influenced by the use of respiratory protection, such as the self-contained breathing apparatus (SCBA). Use of SCBA began in the 1970s, although requirements for use and compliance diffused through the fire service gradually, and SCBA is still not universally used (Austin et al., 2001b).

A cohort study of 101 Swiss firefighters found that firefighters were 3 to 10 times more likely than males from the general public to suffer from burning eyes, running nose, itchy throat, cough, dyspnoea, and headache (Mledinger et al., 2007). Other studies indicate that extreme exposure and long-term exposure in combination with cigarette smoking may be risk factors for respiratory disorders and accelerated decline in airflow (Guidotti, 1992). A study of New York City firefighters suggests that sarcoidosis may be more prevalent among firefighters than EMS responders, although the level of impairment is minimal (Prezant et al., 1999b).

High exposures to a variety of inhaled materials immediately following the World Trade Center collapse led to serious respiratory impairment in New York City firefighters. Eight percent of the firefighters with a high level of exposure developed the "World Trade Center cough," defined as "a persistent cough that developed after exposure to the site and was accompanied by respiratory symptoms severe enough to require medical leave for at least four weeks" (Prezant et al., 2002). Data from the World Trade Center Worker and Volunteer Medical Screening Program indicate that inhalational exposure by rescue and

recovery workers caused several new or worsened respiratory problems and that these conditions persisted for at least 2.5 years after exposure (Herbert et al., 2006).

Other Conditions. Based on the workplace and environmental factors that can lead to post-traumatic stress disorder, firefighters are at relatively high risk (Corneil et al., 1999), although the prevalence of post-traumatic stress disorder among firefighters relative to other occupations has not been well established. Firefighters are exposed to high noise levels, primarily from sirens and engine pumps, and appear to suffer elevated rates of hearing loss (Tubbs, 1995; Kales et al., 2001). Finally, while occupational exposure to infectious diseases is a common concern among firefighters and EMS responders, it is not clear whether this puts them at increased risk of infection.

3.3 Emergency Medical Services

Very few data are available for emergency medical service responder casualties and health, primarily because the emergency medical service is generally not distinguished as a separate occupation in safety and health surveillance systems. Maguire et al. (2002) characterized EMS fatalities by compiling and correlating results from multiple databases. They estimate that there were about 19 EMS responder fatalities per year between 1992 and 1997 (Maguire et al., 2002). Because many EMS responders are also firefighters, some of the EMS responder fatalities may have also been included in the firefighter fatality counts. Based on his findings, most EMS fatalities result from ground-transportation incidents (60 percent), followed by air ambulance crashes (17 percent), cardiovascular incidents (11 percent), assaults (9 percent), and other causes (Maguire et al., 2002). The high rate of fatal assaults reflects the well-documented risk of violence in the emergency medical service, which is attributed to the frequency with which EMS responders provide care to victims of domestic and other types of violence (e.g., Mechem et al., 2002; Lucas, 1999; LaTourrette et al., 2003).

Maguire et al. (2005) examined occupational injuries among EMS responders in two agencies. The most common injury was “sprains,

strains, and tears,” which accounted for 55 percent of all injuries and 63 percent of lost workday injuries. The back was the body part most commonly injured, being more than three times as likely to be injured as any other body part. The predominance of back injuries stems primarily from lifting and carrying patients, often in cramped spaces (Conrad et al., 1994).

3.4 Law Enforcement

Compared with the fire service, fewer data are available about injuries, fatalities, and health outcomes among law enforcement officers. According to the BLS Current Population Survey, there were about 1.3 million law enforcement and corrections officers working in the United States in 2006 (Table 3.2). Of the approximately 900,000 law enforcement officers, about 75 percent are local police and sheriff officers, 13 percent are state, constable/marshal, and special jurisdiction officers, and about 12 percent are federal officers (U.S. Department of Justice, Bureau of Justice Statistics, 2007).

The hazards of law enforcement and corrections work are diverse. Some of the most important hazards include assaults, vehicle collisions, heart disease, and psychological stress (Hessl, 2001; LaTourrette et al., 2003; Houser et al., 2004; Bogucki and Rabinowitz, 2004).

Table 3.2
Number of Law Enforcement and Corrections Officers in 2004

Category	Number
Police and sheriff patrol officers	655,000
First line supervisors/managers of police and detectives	103,000
Detectives and criminal investigators	144,000
<i>Law enforcement subtotal</i>	<i>902,000</i>
Bailiffs, correctional officers, and jailors	451,000
Total	1,353,000

SOURCE: BLS (2007).

Law Enforcement Fatalities

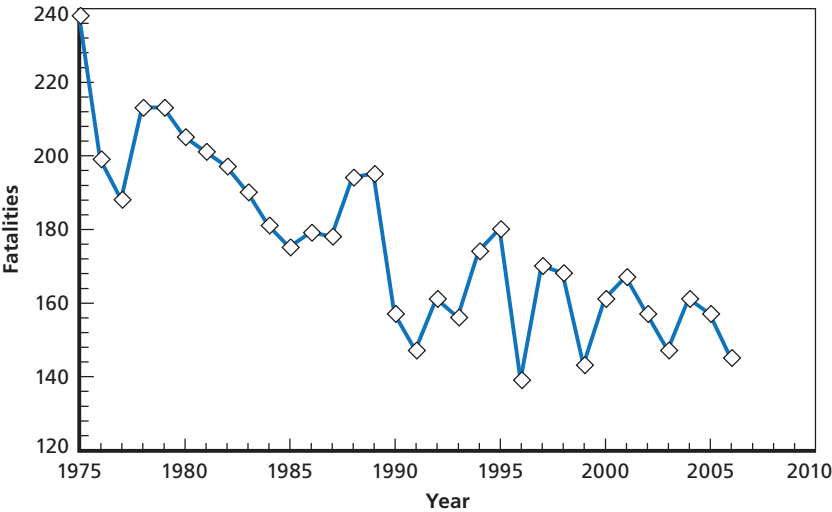
The BLS Census of Fatal Occupational Injuries reported 131 on-duty law enforcement officer fatalities in 2006 (BLS, 2008a). These include fatalities that occurred on or off the employer's premises when the person was there to work, or fatalities that result from an event or exposure that was related to the person's work or status as an employee. For police, homicides occurring off-duty are generally included. Other fatalities to off-duty police are included if they were performing a police-related function, such as directing traffic at the scene of an accident or rescuing someone from a fire (BLS, 2008a). Based on the number of law enforcement officers in Table 3.2, this represents a fatality rate of 14.5 fatalities per 100,000 workers. This value is 3.6 times greater than the national average (Table 3.1). Based on comparable BLS data, Clark and Zak (1999) estimated law enforcement officer fatality rates of 11 to 17 fatalities per 100,000 workers from 1992 to 1997.

The National Law Enforcement Officers Memorial Fund (NLEOMF) also tracks law enforcement officer fatalities and reported 145 on-duty law enforcement officer deaths in 2006 (NLEOMF, 2007a). This value is higher than the BLS estimate because it includes 14 deaths from job-related illness (mostly heart attacks). As noted above, fatal illnesses are not considered injuries and so are not included in the BLS Census of Fatal Occupational Injuries. According to NLEOMF data, annual law enforcement fatalities have decreased at a rate of about 1.2 percent per year over the last 30 years (Figure 3.10). This decrease is similar to that for firefighters (Figure 3.2).

The cause of death for law enforcement officer fatalities from 1997 to 2006 is shown in Figure 3.11. The vast majority (74 percent) of on-duty fatalities result from vehicle accidents and assaults. Shootings represent 94 percent of assaults, accounting for 35 percent of all fatalities. Being struck by a vehicle is the next highest category (10 percent). Heart attacks account for about 6 percent of the deaths, and the 72 police deaths from the 9/11 terrorist attacks account for 4 percent of all police fatalities over the 10-year span of the data shown.

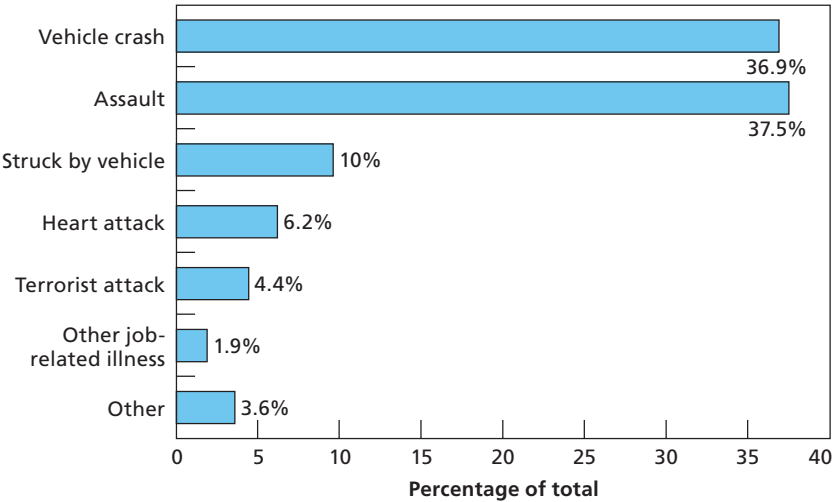
Police officer fatalities can also be examined in terms of the type of duty or circumstances at the time of death. Nearly half are vehicle-related accidental deaths, of which 80 percent are vehicle crashes and

Figure 3.10
Trend in Annual On-Duty Law Enforcement Officer Fatalities, 1975–2006



SOURCE: NLEOMF (2007a).
RAND MG792-3.10

Figure 3.11
Cause of On-Duty Law Enforcement Officer Deaths, 1997–2006



SOURCE: NLEOMF (2007a, 2007b).
RAND MG792-3.11

20 percent are officers being struck by vehicles. Most of the remaining fatalities are about evenly distributed among arrest situations, ambushes, responding to disturbance calls, and murders during traffic stops or pursuits.

Law Enforcement Injuries

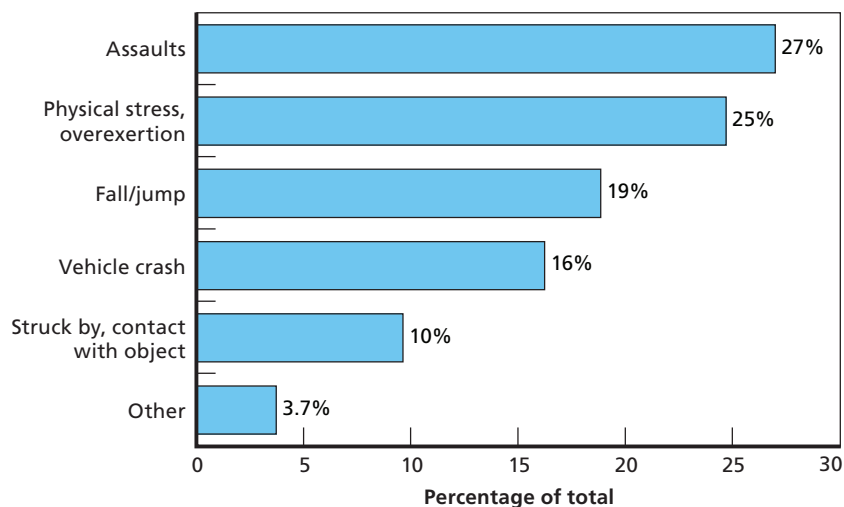
Law enforcement injury data are compiled by BLS, but public sector data are only collected for states that have Occupational Health and Safety Administration (OSHA)–approved safety programs and hence cannot be aggregated at the national level. In addition, because confidentiality requirements prevent publication of low cell counts, only California and New York have large enough injury counts to allow publication of the distribution of injury types (Houser et al., 2004). Figure 3.12 shows the distribution of the cause of lost-workday injuries for local government law enforcement workers in New York from 1998 to 2000. Assaults and physical stress/overexertion account for about half of the injuries, with the remainder consisting primarily of falls and jumps, vehicle accidents, and being struck by or having contact with objects.

To further examine law enforcement officer injuries, we obtained injury data for a large metropolitan police department. The data include the medical nature (classified by ICD9 codes⁵) and duration of line of duty injuries resulting in lost workdays for current department members during the years 1995–2007. The distribution of injuries according to the number of cases is shown in Figure 3.13. These results provide a picture of the distribution of medical outcomes resulting from the injury causes shown in Figure 3.12.

The results show that the majority of injuries (64 percent) are sprains and strains. Of all sprains and strains, 41 percent are back sprains and strains, such that back injuries make up 27 percent of all lost-workday injuries. Bruises and open wounds constitute the next

⁵ The International Classification of Diseases (ICD), maintained by the World Health Organization, is designed to promote international comparability in the collection, processing, classification, and presentation of mortality statistics. The ICD has been revised periodically, and the Ninth Revision (ICD-9) is the working standard in the United States. For more information, see National Center For Health Statistics (2007).

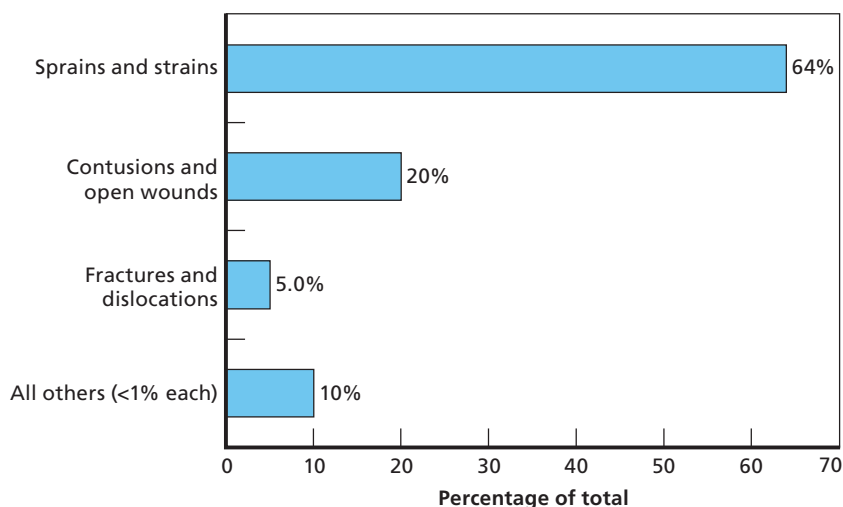
Figure 3.12
Cause of Law Enforcement Officer Lost-Work-Time Injuries in New York, 1998–2000



SOURCE: Houser et al. (2004).

RAND MG792-3.12

Figure 3.13
Nature of Law Enforcement Officer Lost-Work-Time Injuries, 1995–2007



SOURCE: RAND analysis of data supplied by a large metropolitan police department.

RAND MG792-3.13

most common injury type, followed by fractures and dislocations. All other injury types, including heart attacks and stress-related absences, contribute less than 1 percent each. Because these data do not include cases less severe than lost-workday, they are not directly comparable to the fire service data in Figure 3.9. Nonetheless, the injury distribution is broadly similar to that for firefighters (Figure 3.9). In particular, the dominance of sprains and strains and the proportions of cuts/bruises and fractures/dislocations are similar for the two groups. Firefighters appear to be susceptible to a larger number of other injuries, most notably thermal stress, burns, and smoke inhalation.

The average number of lost workdays per injury is 12, with a median of 4 days and a standard deviation of 22 days. Despite the large variation in injury duration, durations are not well correlated with injury type, such that the distribution of injuries according to the duration of absence is very similar to that in Figure 3.13.

Health Outcomes in Law Enforcement Officers

Although several studies have addressed different aspects of health outcomes among law enforcement workers, there are few high-quality analyses. Consequently, few clear links between particular health disorders and law enforcement work have been identified.

Law enforcement may have an increased risk of cardiovascular disease, although not all data support this (see reviews by Hessl, 2001, and Bogucki and Rabinowitz, 2004). As with firefighters, law enforcement officers have been shown to have a higher prevalence of conventional CVD risk factors, including hypertension, high cholesterol, tobacco use, and elevated BMI (Franke, Ramey, and Shelley, 2002, and references therein), confounding potential links to occupational factors. In addition, numerous studies have shown that police work is associated with high stress levels, and some authors have speculated that high stress may represent a CVD risk factor particular to law enforcement work.

Few studies have examined cancer among police workers, though they have identified limited evidence of increased incidences of several types of cancer, including thyroid, testicular, esophageal, brain, colon, kidney, bladder, melanoma, and Hodgkin's disease (Lope et

al., 2005; Finkelstein, 1998; Violanti, Vena, and Petralia, 1998). An early investigation of the potential effects of hand-held traffic radar devices on cancer incidence showed a possible association (Davis and Mostofi, 1993), but subsequent studies have not shown any evidence for an increased cancer risk (Breckenkamp, Berg, and Blettner, 2003; Baumgardt-Elms et al., 2002; Bogucki and Rabinowitz, 2004).

A substantial amount of work has addressed the psychological impacts of police work, and there is evidence that police workers suffer increased stress levels that are manifested in higher rates of alcoholism, gambling, domestic violence, post-traumatic stress disorder, depression, and possibly suicide (Waters and Ussery, 2007; Hessler, 2001; Violanti et al., 1998).

3.5 Discussion

While much is known about the fatal injury risks faced by public safety employees, there are substantial gaps in our knowledge about their nonfatal injury and illness rates. There are some data available about the risks to firefighters, enough to classify the types of injuries that are most common, though they are more heavily focused on injuries that occur at the fireground. There is very little widespread data reporting on nonfatal injury or illnesses for other safety occupations, such as law enforcement. Without better and more consistent surveillance and monitoring systems, it is difficult to draw definitive conclusions about the nature, cause, and severity of the injuries that workers face in the various safety occupations.

The data that are available indicate that injury risks vary according to the specific duties that different public safety workers are engaged in. For example, police face a high risk of death from assaults, and firefighters face a high risk of death from heart attacks at fire responses. Fire, EMS, and police work all involve substantial driving under hazardous conditions, and all three services face a particularly high risk of fatal injury from vehicle accidents. While nonfatal injury risks also vary among the services, one finding that is common across the dif-

ferent safety occupations is that a majority of injuries are strains and sprains, largely involving musculoskeletal disorders.

Characterizing Current Strategies for Reducing Occupational Injuries and Illnesses Among Public Safety Employees

In this chapter, we examine safety and health promotion initiatives in public safety and assess the extent to which these initiatives align with the safety and health risks summarized in the previous chapter. To do so, we use a qualitative approach, integrating information about safety and health risks with information on existing safety and health promotion efforts. This approach combines our previous findings with insights from a series of roundtable discussions with public safety workers from different departments in California.

We first draw on the roundtable discussions and the literature to help understand the different types of safety and health promotion approaches used, their perceived benefits, and impediments to their implementation. We also survey nationally promoted initiatives targeting public safety workers. We then use the literature survey to classify safety and health risks and casualties in different ways to help guide the assessment of safety and health promotion efforts. Based on these findings, we identify the leading safety and health concerns of public safety workers and compare these concerns with the safety and health interventions in use.

4.1 Roundtable Discussions

To help better understand the relationships among hazards, injuries, work environments, and safety and health promotion efforts, we held

a series of roundtable discussions with workers from several public safety departments in California. These roundtable discussions were intended to elicit insights from practitioners about two general aspects of workplace safety and health. First, we wanted to learn about particular injury prevention and other safety and health promotion efforts being used or considered in different agencies and settings. In addition, we wanted to bridge some of the gaps in the casualty surveillance data by better understanding the links between specific types of activities or work environments and specific types of injuries. Such insights are important because injury reduction strategies must address the cause of the injury.

Roundtable discussions were held with representatives of eight public safety departments in California (Table 4.1) between September 2006 and August 2007. Criteria for selecting departments included participation in CalPERs, willingness to participate, RAND having workers' compensation claim data from a prior study (Reville et al., 2001),¹ and budget and logistical considerations. Departments were initially contacted by a letter from the executive director of CHSWC,

Table 4.1
Public Safety Department Roundtable Discussions

Jurisdiction	Service
Oakland	Fire
Oakland	Police
Sacramento	Fire
Sacramento	Police
Santa Monica	Fire
Santa Monica	Police
Los Angeles County	Fire
California	Corrections
California	POST (police)

¹ We initially considered linking results of roundtable discussions to workers' compensation claim data, but eventually abandoned this plan.

which was followed by a phone conversation with the authors. Discussion participants were selected by the departments based on our desire to meet with department leaders whose responsibilities span the range of department activities and that have insights into factors contributing to workplace injuries and efforts to improve safety and health.

We used a standardized discussion protocol to maintain consistency and facilitate comparisons. The protocol, which is provided in Appendix A, addressed operational information (e.g., department size, work activities), safety and health risks, and safety and health promotion efforts. Discussions were conducted in person by the authors and lasted approximately 90 minutes. Discussions typically had 3–6 participants consisting primarily of mid-level management representatives (e.g., police captains or fire battalion chiefs), although senior leadership and rank-and-file representatives were sometimes included. In addition to the public safety departments, we also met with the California Commission on Peace Officer Standards and Training (POST) to gain insights about research and implementation of safety and health promotion efforts in California police departments.

Participant responses were not coded or otherwise quantified. Rather, we used the findings to identify service- and department-specific information that would provide context for understanding relationships between safety and health problems and potential solutions.

4.2 Safety and Health Protection Efforts in the Public Safety Workforce

This section presents findings from the roundtable discussions about the kinds of injury prevention and other safety and health improvement efforts that are being used and about why particular approaches are being chosen.

When asked about safety and health promotion, a common response we received was that departments sought to improve members' physical fitness. All fire and police departments we met with, and most career departments nationwide, have minimum physical fitness requirements for entry into the service. Continuing fitness requirements are

less common, and approaches vary. All of the fire departments noted that they had a standard set of cardiovascular and weight-lifting equipment in all stations, and some had made exercise a mandatory part of firefighters' daily duties. In addition, three of the four fire departments we met with have implemented mandatory annual fitness testing and require firefighters to meet minimum standards to remain on active duty.

The police departments we met with have access to a centralized gym, and some have trainers or physical therapists on staff to provide coaching and other assistance. However, none had a continuing fitness requirement. Police representatives noted that it is more difficult for police to make time to exercise because they continuously patrol rather than deploy out of a station as do firefighters. In addition they indicated that there is a tradition and expectation that officers will stay fit on their own.

Physical fitness was often discussed in the broader context of "wellness," which generally also includes medical monitoring, rehabilitation, and behavioral health. Indeed, several departments noted the importance of good nutrition and provide guidance for healthy cooking as part of the overall wellness program.²

Another commonly cited approach to protecting safety and health was training. Although few specific details were offered, the general message was that more and better training was important for preventing injuries. One example cited by several departments was driver safety training—both fire and police departments lauded the benefit of specialized emergency vehicle operations training. Police also noted that pursuit policies nationwide have become more restrictive in recent years. While they acknowledged that this change is largely motivated by a desire to reduce litigation, they indicated that there are important safety benefits as well. Police also cited self-defense and de-escalation techniques, including pugilistics, ground fighting, and verbal judo, as important for reducing the risk of injury from assaults.

² This issue was noted as being particularly important for firefighters, as they generally work 24-hour shifts and typically shop for, cook, and eat meals while on duty.

Participants in several discussions also highlighted the value of analyzing incidents to extract lessons learned. Participants noted the importance of two types of information sharing. The first is an immediate post-incident analysis by responders and supervisors directly involved in the event. All departments conducted some form of such an analysis, ranging from informal “tailboard critiques” to more formal processes. Some departments also coordinated with city risk managers to conduct periodic analysis of injury data to identify emerging hazards, unsafe behavior, or other safety and health risks. Relevant lessons from both approaches are shared with individuals throughout the department, and participants noted several examples of department policies, protocols, or equipment being changed to improve safety as a result of this process. Departments generally felt that analysis and information sharing was very effective and that more such analysis was needed.

Most of the departments we met with are large, and all are well equipped in terms of personal protective equipment. The fire departments all use full turnout gear and SCBA, and the police departments all require all officers to wear body armor. Compliance was cited as being near 100 percent. Given the near-universal use of state-of-the-art personal protection, we did not discuss the use of personal protective equipment in any detail. Our past research has shown that use of personal protective equipment is, indeed, a critical aspect of protecting the safety and health of emergency responders (LaTourrette et al., 2003).

Other efforts addressing safety and health raised in the discussions include implementing and enforcing seat-belt policies; increasing the use of Tasers by police, which reduces contact with uncooperative or violent people and hence reduces the risk of injury from assaults; policies intended to reduce fatigue requiring minimum time intervals between finishing work at an off-duty job and starting a shift; and an emphasis on a clear and strong safety message from department leadership.

Impediments to Safety and Health Promotion

Roundtable discussions also revealed some issues that were felt to impede safety and health promotion efforts in the public safety workplace. Physical fitness requirements have historically faced resistance

from labor organizations, both in a general effort to protect jobs and on the argument that physical fitness is not necessarily a good measure of job performance or potential for injury. This resistance appears to be waning somewhat, and labor and management representatives are now cooperating to design effective and fair fitness and wellness programs at the national and department levels. Police have made less progress in physical fitness programs because of the difficulties in providing time and equipment for exercise and concerns about increased workers' compensation costs.

Another impediment to fitness programs highlighted in the discussions is that some departments observe a short-term increase in injuries and workers' compensation claims as a result of accidents caused by exercising. A survey of police department health and fitness programs found similar results, which were cited as a real impediment to exercise programs (Krueger and Berner, 1995). This finding presents a paradox for public safety departments in that exercise is viewed as important for improving safety and health on the one hand but is also a common source of injuries on the other.

Police departments indicated that litigious concerns may suppress the sharing of information and lessons learned from accidents. Departments may be reluctant to share such information for fear of interfering with potential lawsuits. More generally, both fire and police departments noted that information sharing may be impeded by a reluctance to admit mistakes for fear of punitive actions. This is particularly the case in the academy or during initial probationary periods of employment.

One general impediment emerged from a cost perspective: Because an employer's workers' compensation costs depend strongly on state regulations and legislation, efforts to revise these regulations can be viewed as a more productive approach to reducing costs than efforts to improve workplace safety and health. At the same time, departments must pay overtime to replace injured workers, and so still have a strong financial incentive to reduce injuries.

Service-Wide Safety and Health Promotion Efforts

In conjunction with the roundtable discussions, we surveyed the communications and Web sites of professional, labor, government, and independent public safety organizations to identify nationally promoted safety and health improvement initiatives targeting public safety workers. Our findings, summarized in Table 4.2, show a strong distinction between firefighters and police. The fire service has put forth numerous safety and health improvement initiatives spanning a wide range of topics and approaches, while we were able to identify only one such effort targeting police. This difference is striking given the similar injury and fatality rates for fire and police demonstrated previously.

In the roundtable discussions, we asked departments whether they were aware of these initiatives, whether they participated in them, and about their impressions of them. Fire departments were generally aware of all of the initiatives³ and participated in several of them, with the first three in Table 4.2 being the most common. Experiences were universally positive, with discussion participants endorsing these efforts as valuable resources. Two of the departments had also participated in safety and health research and pilot-testing efforts. Overall, it was apparent that safety and health is a high priority in the fire service and that attitudes and actions at the department level are influenced by the resources and messages conveyed through these service-wide efforts.

The police departments, in contrast, indicated in the roundtable discussions that they received little guidance from the national level. Discussion participants did mention that safety and health-related information and ideas are shared among departments, but this sharing is informal and restricted to individuals' personal contacts. Departments must work primarily on their own to design and implement safety and health promotion efforts.

³ We did not meet with any volunteer fire departments and so did not ask about the Heart-Healthy Firefighter initiative.

Table 4.2
National Safety and Health Promotion Initiatives Targeting Public Safety Workers

Name	Service	Sponsor	Summary
Joint Labor-Management Wellness/Fitness Initiative	Fire	IAFF and IAFC	Comprehensive, voluntary, and nonpunitive initiative consisting of an overall wellness program addressing physical and mental fitness, a candidate physical ability test to help evaluate the fitness of potential firefighters, and a peer fitness trainer certification program to establish a basis for effectively training firefighters in physical fitness (IAFC, 2008b; IAFF, no date).
Fire/EMS Safety, Health and Survival Week (formerly known as Safety Stand-Down)	Fire	IAFF and IAFC	The annual event calls for all U.S. and Canadian fire departments to suspend all non-emergency activity and instead focus entirely on fire and EMS safety. The goal of the Stand Down is to better prepare firefighters and emergency medical technicians (EMTs) for their daily duties by calling attention to safety practices, proper training and usage of equipment through activities and discussion. The Stand Down is designed to bring international attention to the need to address preventable line-of-duty injuries and deaths among fire fighters (IAFC, 2008a; IAFF, 2007).
National Firefighter Near-Miss Reporting System	Fire	Funded by USFA and Fireman's Fund Insurance Company and administered by IAFC	A voluntary, confidential, non-punitive, and secure reporting system with the goal of improving fire fighter safety. By collecting and analyzing information on near-miss events, improvements can be made in command, education, operations and training. Fire fighters can use submitted reports as educational tools. Analyzed data will be used to identify trends that can assist in formulating strategies to reduce fire fighter injuries and fatalities. Depending on the urgency, information will be presented to the fire service community via program reports, press releases and e-mail alerts (National Fire Fighter Near-Miss Protection System, no date).
Everyone Goes Home Firefighter Life Safety Initiatives	Fire	National Fallen Firefighters Foundation	A national program to bring efforts to prevent line-of-duty deaths and injuries to the forefront. The central element is the 16 Life Safety Initiatives that span cultural, change, risk management, fitness, technology, certification and standards, protocols, education, and more (Everyone Goes Home Firefighter Life Safety Initiatives, 2008).

Table 4.2—Continued

Name	Service	Sponsor	Summary
Emergency Vehicle Safety Program	Fire	USFA and the U.S. Department of Transportation	The long-term goal of this project was to reduce the number of firefighters killed responding to and returning from emergencies. Through research and forums, the effort developed draft “best practices” guidelines, mitigation techniques, and technologies; pilot-tested these tools; obtained consensus endorsement of them; and distributed them to local fire departments (USFA, 2007a).
Heart-Healthy Firefighter	Fire	National Volunteer Fire Council	The only national program dedicated to saving America’s firefighters and EMS personnel from their leading cause of death: heart disease. Program addresses fitness, nutrition, and lifestyle factors (National Volunteer Fire Council, no date).
Law Enforcement Stops and Safety	Police	IACP	Seeks to ensure officer safety during traffic stops and other roadside contacts. Goals include examining the factors which lead to law enforcement fatalities and injuries related to vehicle crashes, developing strategies dealing with law enforcement vehicles, identifying procedures and best practices, improving public awareness of traffic scene safety, and exploring highway and engineering improvements (IACP, 2003).

NOTES: IACP = International Association of Chiefs of Police; IAFC = International Association of Fire Chiefs.

4.3 Comparing Safety and Health Risks and Promotion Strategies

When considering ways to improve safety and health of public safety workers, it is useful to classify casualties in ways that help ensure that safety and health promotion efforts target the most important risks. Casualties can be classified according to the severity of injuries, the number of workers affected, the amount of lost work time, the number of disabilities caused, and other measures. Using different criteria may lead to differences in how safety and health interventions are designed and prioritized.

Table 4.3 shows the most important safety and health concerns for fire, EMS workers, and police according to four different classification criteria: severity, frequency, lost work time, and type of duty. The priorities listed are drawn from the data summarized in Chapter Three. When injury severity is the criterion, fatal injuries are the highest priority. In this perspective, heart attacks and vehicle accidents are the greatest concerns for the fire service, and vehicle accidents are the greatest

Table 4.3
Safety and Health Priorities Using Different Classification Criteria

Service	Severity (% of fatalities)	Number of Cases (% of cases)	Lost Work Time (% of lost work time)	Type of Duty (% of fatal/ nonfatal injuries)
Fire	Heart attacks (48%) Vehicle accident (22%)	Strains and sprains (59%)	Not available	Fireground operations (32%/53%)
EMS	Vehicle accident (77%)	Strains and sprains (55%) ^a	Strains and sprains (63%) ^a	Driving (77%/19%) Lifting (0%/42%)
Police	Vehicle crashes (37%) Assaults (37%) ^b	Strains and sprains (64%; 42% of which are back)	Strains and sprains (63%; 33% of which are back)	Driving (37%/16%) Traffic stops and directing traffic (18%/NA)

SOURCE: Compiled from results presented in Chapter Three.

^a Across all nonfatal injuries, the back is three times more likely to be injured than any other body part for EMS responders.

^b 94 percent of fatal assaults on police are shootings.

concern for the emergency medical service. Vehicle crashes and assaults (primarily shootings) are the highest priority for police.

When the criterion is the number of cases or the amount of lost work time, strains and sprains are the primary safety and health concern for all three services. Back injuries are the most common for the emergency medical service and police; data about body parts injured are unavailable for the fire service.

Finally, a different way to classify casualties is by the type of duty responders are engaged in when injured. This perspective reveals that firefighting is the most hazardous activity for firefighters and lifting and that transporting patients is the most dangerous for EMS responders. For police, driving is clearly the highest-risk activity, with activities conducted outside vehicles in traffic, such as traffic stops and directing traffic, also being high-risk.

The findings shown in Table 4.3 provide a basis for guiding the design and prioritization of safety and health improvement efforts. However, the ability to design effective interventions is hampered by some limitations in the data summarized in Table 4.3. In particular, little information is generally available about the indirect causes of injuries, such as command decisions or responder condition prior to injury. In addition, while injury cause and injury nature are generally available in aggregate, there is no information about the different types of injuries that result from particular causes.⁴ Finally, details about the nature of the accident or victim are often unavailable (e.g., weather conditions or victim's work experience).

There are important differences in the way injuries are reported and classified and in the compensation options available among public safety services and between public safety and other occupations. Consequently, we caution against comparing results across rows in Table 4.3 or comparing the results in Table 4.3 with results for other occupations.

⁴ While BLS maintains this type of information, it is primarily for private employers and thus does not cover most public safety workers.

Time Spent on Primary Work Activities

The public safety work environment is characterized by a wide range of activities and work environments. As noted in Chapter Three, the safety and health risks vary considerably among different activities, as does the amount of time spent on them. Hence, an important issue for addressing workplace safety and health is characterizing the different activities involved.

In the roundtable discussions, we asked department representatives to list the primary tasks that staff members participated in and to estimate the amount of time spent on each. In response, representatives emphasized that the distribution of time among tasks was extremely heterogeneous and could vary considerably among stations,⁵ staff assignments (e.g., paramedics respond more frequently than basic firefighters; some special operations units respond less and train more), seasons, and other factors. They also noted that training is difficult to account for because it is administered at multiple intervals ranging from multi-year to weekly training elements. Nonetheless, estimates from different fire and police departments (Tables 4.4 and 4.5) showed a reasonable level of consistency.

Table 4.4
Approximate Time Spent on Primary Work Activities for Four Fire Departments

Activity	1	2	3	4	Best Estimate
Incident response	52%	25%	25%	8–42%	30%
Down time (including sleeping)	30%	35%	25%	8–33%	30%
Maintenance, administration, and housekeeping	8%	15%	30%	4–63%	20%
Training	1%	30%	10%	8%	10%
Inspections	4%	5%	5%	8–25%	5%
Outreach and education	4%	0%	5%	4–7%	5%

SOURCE: Roundtable discussions in this study.

⁵ This is particularly the case for fire departments because stations must be distributed in such a way as to ensure rapid response times regardless of the number of calls for service. Stations in more sparsely populated areas will receive fewer calls and spend less time responding than stations in more densely populated areas.

Table 4.5
Approximate Time Spent on Primary Work Activities for Two Police Departments

Activity	1	2	Best Estimate
Patrolling or responding			
In car	60–70%	60–70%	65%
Out of car	30%	20%	25%
In station		10%	9%
Training	1%		1%

SOURCE: Roundtable discussions in this study.

These time distributions provide useful context for understanding safety and health risks. For example, the high risk of vehicle accidents among police is at least in part explained by the high fraction of time officers spend in their cars. Officers also spend a significant fraction of their patrol time out of their cars in direct contact with the public, where they are vulnerable to assaults and being struck by vehicles.

For firefighters, these results demonstrate that incident response is a disproportionately high-risk activity. As noted in Chapter Three, over 70 percent of both fatal and nonfatal injuries occur during emergency activities. This incidence rate is much greater than the approximately 30 percent of time spent on incident response.

Correspondence Between Safety and Health Risks and Promotion Strategies

In this section, we assess the extent to which the safety and health concerns for each of the classification criteria in Table 4.3 align with safety and health promotion efforts in use. Because the results for frequency and lost work time impacts are very similar, we group these perspectives together in our discussion. The objectives are to assess the extent to which safety and health promotion efforts are appropriately targeted and to help identify safety and health risks receiving insufficient attention or safety and health promotion efforts that are misdirected or unwarranted.

Severity. Based on a criterion of severity, safety and health risks with the greatest impact are fatal injuries, which consist primarily of heart attacks and vehicle accidents for fire and the emergency medical service and vehicle accidents and assaults for police (Table 4.3).

As discussed previously, the risk of heart attacks in the fire service is attributable to both greater incidence of cardiovascular risk factors among firefighters compared with the general public and to job-related factors. The roundtable discussions and national initiatives indicate that this risk is being addressed through the high priority placed on wellness. Efforts to promote wellness, including physical fitness, medical monitoring, nutrition, and behavioral health, help mitigate several primary and predisposing risk factors for heart disease, including high total and LDL (low-density lipoprotein) cholesterol, high blood pressure, obesity, and physical inactivity (Grundy et al., 1999).

The fire service, emergency medical service, and police place a high priority on vehicle and driving safety, through driver training programs (e.g., an emergency vehicles operator's course), driving policies that enhance safety, and safe vehicle design. As discussed in Chapter Three, about half of all vehicle accident-related fatalities in the fire service involve volunteers in private vehicles or water tenders. Thus, vehicle safety efforts in the fire service may be most effective by targeting primarily volunteer departments. In addition, failure to use seatbelts is an important contributing factor to fire and EMS fatalities caused by vehicle crashes. Seventy-six percent of the firefighters killed in vehicle accidents in the last 30 years were known to be not wearing a seatbelt (Fahey, LeBlanc, and Molis, 2007). Similarly, analysis by the CDC (2006) found that 33 percent of EMS responders killed in ambulance crashes over a 10-year period were not wearing seatbelts in the front compartment of ambulances, and another 22 percent were not wearing restraints while riding in the patient compartment. While seatbelt compliance is an important part of most driver safety training programs, there is clearly much room for improvement. For example, one of the fire departments we met with in the roundtable discussions noted that, although they have a seatbelt requirement, enforcement is "not that draconian."

Driving is clearly a very hazardous activity for police, although the data do not allow us to distinguish the relative risks of driving under different circumstances, such as patrolling, responding to calls, or pursuits. A major challenge for police is that, on top of the driving risks posed by specific policing activities, the sheer amount of time spent driving contributes to the risk (Table 4.5).

Police are acutely aware of the risk of assaults and have developed training programs and practices that address this risk, including self-defense, verbal de-escalation, nonlethal weapons, and use of body armor. An important gap in addressing assault risk is the nonuniversal use of body armor among local police in the United States. Despite that fact that all three of the departments we met with require all officers to wear body armor, nationwide only 59 percent of police work in departments that require all officers to wear body armor (Hickman and Reaves, 2006). When shot in the torso, officers wearing body armor are 14 times more likely to survive than those not wearing it (FBI, 1994). Given that gunshots account for approximately 35 percent of police deaths (Figure 3.11 and Table 4.3), promoting more comprehensive use of body armor could potentially be a valuable undertaking.

Number of Cases and Lost Work Time. When examined from the perspective of injury frequency and amount of lost work time, the highest priority safety and health concerns for all public safety workers are strains and sprains, particularly of the back (Table 4.3). As noted in Chapter Three, strains and sprains also dominate the medical costs for workers' compensation claims among firefighters.

One common cause of back injuries in the fire service and the emergency medical service is lifting and carrying patients on medical calls. Research focused on the ergonomics of this activity has led to prototype interventions specifically targeting this risk (Conrad et al., 2008). Police reported in roundtable discussions that foot pursuits were a common source of strains and sprains. Officers are at increased risk for falls and twisted ankles when pursuing suspects, particularly over uneven surfaces, fences, and other obstacles. The risk is exacerbated by the need to keep visual contact with the suspect's hands, which can prevent an officer from watching his or her step.

Little research has examined the causes of musculoskeletal injuries for public safety workers, which greatly limits the ability to design effective interventions. Other specific causes and possible interventions may be identified through systematic analysis of incident data and sharing of lessons learned. Hence, intradepartmental and servicewide information sharing efforts, such as the near-miss reporting system, may prove useful.

In general, however, strains and sprains arise from a wide variety of causes, making it difficult to design interventions specifically targeting this type of injury. The emphasis in public safety on wellness, particularly maintaining a healthy body weight and staying physically fit, may have a beneficial effect. Some recent studies have shown a strong association between obesity and the probability of sustaining an injury (Finkelstein et al., 2007; Xiang et al., 2005) and the rate, duration, and cost of workers compensation claims (Østbye, Dement, and Krause, 2007). There is also limited evidence linking greater fitness to lower overall injury rates (Nabeel et al., 2007; Shephard, 1996; Kaufman, Brodine, and Shaffer, 2000) and to decreased back injuries in particular (Studnek and Crawford, 2007; Smeets et al., 2006; Feuerstein, Berkowitz, and Huang, 1999; Lahad et al., 1994). Because there is no single risk factor associated with injuries and back pain, a multifaceted injury prevention program may be warranted (e.g., Kim, Hayden, and Mior, 2004).

Given the nonspecific origin of sprain and strain injuries, the most effective interventions may entail more general safety considerations, such as those embodied in the Everyone Goes Home Firefighter Life Safety Initiatives (Table 4.2). Although primarily focused on preventing firefighter deaths, many of the initiatives address unsafe behaviors and could help reduce injuries as well.

Type of Duty. The final casualty classification perspective we consider is type of duty. Type of duty is a useful perspective for classifying injuries and identifying interventions in public safety because of the wide range of activities undertaken in public safety work.

As noted previously, firefighters are at the highest risk for injury during firefighting, and the fire service has examined fireground injuries in detail. The data show that fireground injuries and fatalities span

a wide range of causes, including overexertion and strain (comprising primarily heart attacks); slips, trips, falls, and jumps; exposure to fire products and chemicals; being struck by or having contact with objects; and getting caught or trapped (leading to asphyxiation) (USFA 2004b, 2008b). While some causes (e.g., burns) and many circumstances (e.g., falling through a collapsed floor) are clearly specific to fire environments, many others are not, which suggests a causal factor at work in fire responses that is more general than the fire operations themselves.

The relatively higher risk of injury at fire responses is often attributed to higher levels of stress and risk-taking resulting from a convergence of factors, such as the desire to save lives and property, time-sensitivity and associated rushing, the presence of multiple hazards, and communications difficulties. This situation has fueled an ongoing debate in the fire service about risk-benefit trade-offs and the appropriate level of risk under different conditions.

Demonstrable progress in addressing this problem is limited. One trend highlighted in the roundtable discussions and trade reports is that fire departments are increasingly instituting policies that prohibit offensive suppression tactics (i.e., entering the structure) at fires in unoccupied structures. Such policies are based on the argument that there is no justification for putting firefighters at the increased risk associated with an offensive fire attack when no lives are threatened. However, using only defensive tactics increases the risk of a fire spreading to adjacent structures, illustrating the difficulty in making definitive policies of this sort.

For the most part, however, few specific changes or interventions have yet to be identified and implemented. Rather, efforts have focused on more overarching topics, such as fire service culture, tradition, and leadership. The concept of “safety culture” or “safety climate” (management commitment to safety, return-to-work policies, post-injury administration, and safety training) has been examined in the occupational safety and health literature and has been shown to be a good predictor of occupational injury rates (e.g., Huang et al., 2006; Cullen et al, 2005; Gillen et al., 2002; Glazner et al, 1999). Numerous fire service trade reports and speeches have called for “cultural change” in the fire service, decrying norms that accept unsafe behaviors or actions on

the grounds that “that’s just the way we are” (e.g., Stagnero, 2006). This commitment to change is embodied in several of the Everyone Goes Home program’s 16 “life safety initiatives” (Table 4.2) that directly address culture and leadership. A safety culture stems from management practices, and the company officer, in particular, has been identified as playing a critical role in fostering safe behavior in the fire service (Oklahoma State University, 2008). This view was also expressed in the roundtable discussions, in which participants emphasized that attitudes about safety are generally a direct outgrowth of the guidance and examples set by department leadership.

In practice, implementing such cultural change in the fire service has proven problematic. Reasons for this may include the highly decentralized structure of the fire service, lack of clarity about what the desired cultural change would look like, and a deeply rooted sense of tradition that can be resistant to change.

The most hazardous types of duty for EMS responders (driving and lifting) and one for police (driving) have been addressed in the preceding two sections. The other hazardous duty identified for police is engaging in activities outside vehicles in traffic. These activities may include traffic stops, assisting motorists, directing traffic, setting up barricades, or other tasks. The national Law Enforcement Stops and Safety (LESS) program (Table 4.2) addresses this risk through conducting surveys, compiling research results, and sharing best practices. Traffic-related hazards to pedestrian officers were not raised in the roundtable discussions, nor were the participants aware of the LESS program. This suggests that the program may need to increase its outreach efforts to be sure that findings are reaching local police departments around the country.

4.4 Discussion

There appear to be a number of possible opportunities for improving the safety and health of police officers, firefighters, and other public safety employees. Improved surveillance and monitoring systems, training, modifications to protective equipment, and changes in culture

and command guidance all emerged as promising tools for improving safety. However, there are a number of challenges that must be overcome in order to act on any of these items. Surveillance systems, training, and equipment modifications all potentially involve investments of time and money, and budgets for safety departments, as with public agencies in general, are often tight. While the implementation of management practices that promote safety could be beneficial in theory, in practice it appears very difficult to define the appropriate practices and instill them in a meaningful way.

At the national level, the fire service has generally been more proactive than law enforcement in promoting safety and health initiatives. A number of the existing interventions appear to be targeted at improving fitness and wellness, ostensibly in an attempt to reduce the number of heart attack deaths among firefighters. However, more work needs to be done to assess whether these, or other, interventions can help reduce strains and sprains, the leading type of injury among all safety occupations.

The Health of Public Safety Workers Relative to That of Other Workers

The evidence summarized in Chapter Three clearly indicates that public safety occupations are dangerous, but whether this danger translates into relatively poor health for public safety workers is less clear. In this chapter, we employ nationally representative data from the Current Population Survey (CPS) and the National Health Interview Survey (NHIS) to compare the health of public safety workers with that of workers in other occupations. Using the CPS, we first compare the incidence of disability and receipt of disability payments across occupations. We then employ the NHIS to compare other measures of health across occupations, such as the incidence of pain, functional limitations, and chronic disease.

Studies that examine the health outcomes for public safety employees relative to other occupations face a potential limitation referred to as the “healthy worker effect.” This term refers to the fact that some workers are selected in such a way as to be healthier than the population with which they are compared (e.g., Choi, 2000). This effect is relevant to public safety work because entrance into a safety career generally requires health and fitness levels that are relatively higher than for the average occupation. As a result, for example, individuals that enter the firefighting workforce are healthier than average workers and might remain so while they are employed as firefighters. Consequently, occupational effects aside, the disability and illness rates of workers in public safety careers might be lower than the general working population (Choi, 2000).

In addition, the data that we examine in this chapter include no information on workers who died as a result of any occupational hazards.¹ For these reasons, the relationships that we find in this chapter will not necessarily represent causal relationship. This is important to keep in mind when interpreting our results.

These analyses should be considered exploratory in nature. Our intention is not to test specific *causal* hypotheses that emerge from a well-defined model of occupation and health, but rather to document the extent to which the incidence of disability and measured health conditions vary across occupational groups employing nationally representative data sets. As such, we test a large number of hypotheses, and it is possible that some differences in the incidence of disability and health conditions across occupational groups that we document reflect statistical chance rather than real differences. For this and other reasons we discuss below, the differences documented here require further study and validation.

5.1 The Incidence of Disability Across Occupations in the Current Population Survey

In this section, we report comparisons across occupations of the incidence of work-related disability. We employ data from the March Annual Demographic File of the CPS. The CPS is a monthly survey of U.S. households conducted jointly by the U.S. Census Bureau and the BLS.² In March of each year, the CPS asks a wide-range of demographic-related questions in addition to a battery of questions about current employment and employment over the past year. Although the March CPS contains a large number of respondents each year (on average, about 123,000 individuals age 18–65), the number of respondents who report working in public safety occupations is relatively small. Thus,

¹ This will bias us against finding an effect on acute events and conditions that result in death, such as a fatal heart attack with no prior diagnosis of heart trouble.

² For more information about the CPS, please visit the CPS Web site (U.S. Census Bureau, 2008).

in order to increase sample size, we pool CPS data between 2003 and 2007.³

Our sample consists of males who reported being employed in the last calendar year. We restrict our sample to men since public safety occupations are still largely performed by men and CPS sample sizes are not large enough to estimate models separately for women.⁴ Occupation is reported for the most significant job an individual held during the previous year. We employ occupation in the last year rather than current occupation because current occupation is not asked of individuals who are currently not in the labor force (defined as being neither employed nor unemployed). Individuals not in the labor force are of particular interest to us, since individuals unable to work for reasons of disability fall into that group.

We measure disability rates in a number of ways. First, we form a variable that records whether an individual reports having a health problem or disability that prevents him from working or which limits the kind or amount of work he can do. Second, we form a variable that records whether an individual reports having ever retired or left a job for health-related reasons. Third, we construct a variable that measures whether an individual reports currently receiving any disability income. Disability income includes income from workers' compensation or private or public disability programs, but does not include income from Social Security or the Veterans Administration. Finally, we generate a variable that measures whether an individual reports currently receiving income from workers' compensation alone. Also of interest is the respondent's self-assessment of current health (poor, fair, good, very good, or excellent). We categorize individuals as being in poor health if they rate their health as being poor or fair.

³ We begin our sample in 2003 since the CPS redefined its occupational categories in that year. 2007 was the last wave of data available at the time these analyses were conducted.

⁴ In 2007, 83 percent of police officers, 93 percent of firefighters, and 70 percent of corrections officers were men (see below for definitions of these occupational classes); 51 percent of all workers were men. We could estimate models including both men and women and control for gender, but such a model is likely to generate coefficient estimates that are difficult to interpret, since men and women likely perform qualitatively different functions in their occupations and have varying levels of susceptibility to injury and disease.

Since currently disabled workers are more likely not to have worked in the past calendar year than nondisabled workers, we likely underestimate disability rates in the overall population. This is a problem if this underestimation affects some occupations more than others, which is likely if disability spells vary across occupations. For example, if disabled public safety workers tend to experience relatively long spells of disability, they are less likely to have worked in the past calendar year and hence be in our sample than are workers whose disability spells are relatively short. This will cause us to underestimate current disability rates among public safety workers more than we do for other occupations. Unfortunately, we have no way to gauge the importance of this bias.

The fraction of the sample falling into the employment category “not in the labor force, unable to work” increases strongly with age (18–29: 1.8 percent; 30–39: 2.6 percent; 40–49: 4.7 percent; 50–59: 8.4 percent; 60–65: 9.6 percent). These individuals are much more likely to not be working in the previous year and hence have no occupational data. So, in an effort to reduce the impact of any potential bias attributable to dropping individuals who did not work last year, we limit our sample to men age 18–50 for whom the probability of not working in the past year due to disability is relatively low.⁵

We also note here that the occupation reported by individuals in the CPS may not be the job in which they have the most tenure. For example, individuals who left a public safety career and then began working part-time in some non-safety job would be classified in the non-safety occupation, even though their earlier public safety job may have been their “career” job. This could lead to the same type of sample-selection bias discussed above if public safety workers who become disabled subsequently select non-safety occupations.

We divide the CPS sample into 12 occupational groups (dropping individuals working in the armed forces). These groups are officials and

⁵ We obtain the same qualitative results reported in Tables 3.1 and 3.2 when we maintain the full sample age 18–65.

managers, professionals, health care workers,⁶ service workers, clerical workers, construction workers, operators, laborers, transportation workers, police officers, firefighters, and correctional officers.⁷

Table 5.1 tabulates the means of the disability variables defined above by occupation.⁸ The table suggests that police officers and firefighters are less likely to be disabled than workers in other occupations. The percentage of police officers and firefighters reporting they have a disability that prevents or limits the kind of work they do is less than half that of other occupations (0.7 versus 2.1 percent).⁹ They are also much less likely to report having quit or retired from a job for health-related reasons or to assess their current health as either poor or fair. More than a quarter (27 percent) of men working in non-safety occupations assess their health as poor or fair, compared with about 16 percent of men working in police or fire occupations. Men working as corrections officers experience disability and poor health at about the same rate as men in other occupations.

Conversely, the table shows that the percentage of men receiving disability and workers' compensation income is higher among public safety workers than it is among other workers. For example, about 2 percent of police and correctional officers and 1.7 percent of firefighters report receiving workers' compensation income. This compares with 0.8 percent of non-safety workers overall. Only transportation workers have workers' compensation claim rates that approach those of public safety workers.

⁶ The category "health care workers" includes workers in private protective service occupations.

⁷ Police officers include the categories "police officers," "detectives and criminal investigators," "transit and railroad police," and "first-line supervisors/managers of police and detectives." Firefighters include the categories "fire fighters," "fire inspectors," and "first-line supervisors/managers of fire fighting and prevention workers." Correctional officers include the categories "bailiffs, correctional officers, and jailers" and "first-line supervisors/managers of correctional officers."

⁸ Means are weighted employing CPS-generated person weights.

⁹ Throughout this chapter, readers can assume that differences in means and coefficient estimates described in the text are statistically significant at the 5 percent level or better unless otherwise noted.

Table 5.1
Incidence of Disability, by Occupation

Occupation	Number of Obs.	Health and Disability Measures (%)				
		Disabled	Left Job Because of Poor Health	Poor Health	Receive Disability Income	Receive Workers' Comp. Income
Police	2,215	0.7*	0.4*	16.3*	0.1**	2*
Fire	1,027	0.7*	0.6	15.7*	0.3	1.7**
Corrections	813	1.6	1	25.2	0.4	2.1**
Non-safety	202,709	2.1	0.9	27.2	0.2	0.8
Officials and managers	28,915	1.1	0.7	19.7	0.1	0.3
Professional	27,168	1.3	0.8	19.1	0.2	0.3
Health care	7,232	1.8	1.1	22.5	0.3	0.7
Service	43,194	2.5	1	27.1	0.2	0.5
Clerical	13,078	2.7	0.9	26.9	0.2	0.9
Construction	30,130	2	1	31.9	0.2	1.3
Operators	19,989	2	1	30.7	0.3	1.4
Laborers	12,963	2.4	1.1	33.9	0.2	1.3
Transportation	20,040	3.1	1.2	33.5	0.4	1.8

SOURCE: March CPS, 2003–2007.

NOTES: Sample restricted to men age 18–50. See text for additional sample restrictions. Means are weighted employing CPS-generated person weights.

* Mean is statistically different from mean for non–public safety workers at the 1 percent level.

** Mean is statistically different from mean for non–public safety workers at the 5 percent level.

It is possible that the differences in means by occupation reported in Table 5.1 reflect differences in demographic characteristics. To account for this possibility, we adopt a statistical model that isolates the impact of occupation independent of demographic characteristics, such as age and education. Specifically, we estimate a logistic model where the dependent variables are the disability variables listed in Table 5.1 and the independent variables are occupational choice (police, fire,

corrections, and non-safety workers), age (18–29, 30–40, 41–50), education (no high school degree, high school degree, some college, college degree, advanced degree), race/ethnicity (white, black, Hispanic), marital status (married, divorced, widowed, never married), and survey year (2003–2007).¹⁰

Table 5.2 reports estimated odds ratios for police, fire, and corrections occupations generated from these logistic regressions. These odds ratios can be interpreted as the relative odds that individuals in these occupations experience a given disability or health condition. For example, the estimated odds ratio of 0.264 in the first column of Table 5.2 indicates that, conditional on demographic characteristics listed above, the odds that men working in police occupations experience a work-limiting disability are about 26 percent of the odds for men working in non-safety occupations. This estimate is statistically significant at the 1 percent level.¹¹

The regression results reported in Table 5.2 confirm the pattern of results reported in Table 5.1. Conditional on included demographic characteristics, men working in police and fire occupations are less likely to report being disabled and to report being in poor or fair health than are workers in non-safety occupations. For example, the odds that police officers report a current disability are about 74 percent less, and for firefighters they are about 68 percent less, than for workers in non-safety occupations. The point estimate implies that corrections officers are also less likely to experience disability and poor health than are non-safety workers, but these differences are statistically insignificant. The logistic regression results also indicate that public safety workers are more likely to receive workers' compensation than are non-safety workers. There is no statistically significant difference in the likelihood that public safety workers receive other forms of disability income.

¹⁰ All independent variables are specified as categorical variables.

¹¹ This should not be confused with the relative risk, or risk ratio, which is the ratio of probabilities of an outcome in two groups.

Table 5.2
Effect of Occupation on the Incidence of Disability in the CPS: Odds Ratios Relative to Non-Safety Workers

Dependent Variable	Police	Fire	Corrections
Disabled	0.264*	0.316**	0.720
Quit for health reasons	0.471**	0.519	0.891
Poor health	0.618*	0.518*	0.918
Receives disability income	0.605	1.756	1.296
Receives workers' compensation	2.212*	1.931**	2.158*

SOURCE: March CPS 2003–2007.

NOTES: Each cell reports the estimated odds ratio from a logistic model of the incidence of disability (as measured by the variables listed in the first column) on occupational choice and a set of covariates described in the text above. The excluded occupational group is non–public safety workers. CPS-generated person-level weights are employed. Sample restricted to males age 18–50. See text for additional sample restrictions and Table 5.1 for sample sizes.

* Significant at the 1 percent level.

** Significant at the 5 percent level.

5.2 The Incidence of Poor Health Across Occupations in the National Health Interview Survey

The NHIS is the principal source of information on the health of the civilian, noninstitutionalized, household population of the United States. The survey is conducted annually by the CDC’s National Center for Health Statistics (NCHS).¹² In recent years, the survey has sampled between 35,000 and 40,000 households. In this study, we employ data collected between 2001 and 2005.¹³

For each household, the NHIS collects a limited amount of information on all household members. It then collects more detailed information for one randomly selected child (under age 18) and one randomly selected adult, known as the “sample child” and “sample adult,”

¹² For more information on the NHIS, please visit the NHIS Web site (CDC, 2008).

¹³ The NHIS first began asking individuals who are not currently in the labor force about their previous occupation in 2001. 2005 was the more recent survey wave available at the time we prepared the data for this study.

respectively. In this study, we employ data for sample adults only, since these are the only household members who are queried about their occupation.

The NHIS asks sample adults who have ever worked to report their most recent occupation (current occupation for those individuals currently working, and most recent occupation for those not currently working). Consequently, a much larger fraction of those individuals who are not currently in the labor force is queried about occupation in the NHIS than in the CPS. This presumably reduces the potential for sample-selection bias discussed above, although our results are still subject to the problem that occupation refers to the current or most recent job, which may not correspond to an individual's "career" job.

The NHIS data contain 58,519 men age 18–65 in the sample adult file. Of these men, 1,403 reported that they had never worked and so were dropped from the file. About 4 percent (2,262 individuals) of the remaining sample were then dropped because they did not report an occupation. The proportion of individuals not reporting an occupation was about 3.7 percent among those in the labor force and about 5.5 percent among those not in the labor force.¹⁴ We also dropped individuals working for the U.S. military and individuals working in private household occupations (only 21 men in our NHIS sample reported this occupational class). As with the CPS, we restrict our NHIS sample to men because only a small number of NHIS sample women work in public safety occupations.

The NHIS coding scheme permits a similar, but not identical, classification of occupations as in the CPS. They are as follows: officials and managers, professionals, technicians, sales workers, clerical workers, service workers, farmers, precision production workers, operators, laborers, transportation workers, police officers and firefighters, and other protective service workers. The occupational coding scheme employed by the NHIS between 2001 and 2004 does not allow us to create separate categories for police and firefighters. Moreover, cor-

¹⁴ By contrast, in our CPS sample, 1.7 percent of those in the labor force do not report occupation for the previous calendar year compared with 69 percent of those not in the labor force.

rections officers are never identified separately in the NHIS, the relevant category is only “other protective service workers,” which includes both public and private public safety workers.¹⁵ Thus, we label all other workers in the NHIS as “non-protective service workers,” as opposed to “non-safety workers” as in the CPS.

The NHIS contains a rich array of data on health conditions and behaviors. We categorize these variables into six broad groups: disability and injury, subjective health and functional limitations, pain, chronic disease, mental health conditions, and health behaviors. Table 5.3 lists the variables we construct within each of these categories and their definitions. Tables 5.4–5.9 tabulate the means of the health variables defined in Table 5.3 by occupation.

As in the CPS, it is important to acknowledge that all of these NHIS variables are generated from self-reports, and one might be concerned that some individuals are more likely to report particular health conditions than others for reasons that have nothing to do with the actual incidence of such conditions. For example, some individuals may be more likely to visit a doctor than others and so be more likely to receive diagnoses for particular health conditions. Differential mortality can also influence the likelihood of reporting a given health condition. In the case of heart attacks, for example, individuals who receive more prompt care may be more likely to survive a heart attack and so be more likely to report having had a heart attack in the NHIS.

Our primary concern in this chapter is in describing the variation in the incidence of self-reported disability and health conditions across public safety and non-safety occupations. Consequently, we are most concerned whether the potential reporting issues described in the previous paragraph affect public safety workers more than other workers. Unfortunately, we have no hard evidence either way. One might hypothesize that public safety workers have greater access to medical care and perhaps receive more prompt treatment for life-threatening health conditions such as heart attacks than do other workers, but we simply do not know whether this is in fact true, and, even if it is, the degree to which these reporting issues influence the likelihood of

¹⁵ See NCHS (2006) for information on occupational coding in the NHIS.

Table 5.3
NHIS Health Variables

Variable Name	Definition
A. Disability and Injury	
Disabled	Unable to work due to health problem
Work limitation	Limited in the amount or kind of work able to perform
Injured	Injured in the past three months
Injured at work	Injured at work in the past three months
B. Subjective Health and Functional Limitations	
Poor health	Assessed health as poor or fair
Functional limitation	Reports any functional limitation
Chronic functional limitation	Reports any chronic functional limitation
C. Pain	
Neck pain	Experienced neck pain in past three months
Back pain	Experienced back pain in past three months
Leg pain	Experienced leg pain in past three months
Jaw pain	Experienced jaw or face pain in past three months
Migraine	Suffered a migraine headache in the past three months
D. Chronic Disease	
Hypertension	Ever diagnosed with hypertension
Heart disease	Ever diagnosed with coronary heart disease
Angina	Ever diagnosed with angina pectoris
Heart attack	Ever had a heart attack
Other heart condition	Ever diagnosed with some other heart condition
Stroke	Ever diagnosed with stroke
Emphysema	Ever diagnosed with emphysema
Asthma	Ever diagnosed with asthma
Ulcer	Ever diagnosed with an ulcer
Cancer	Ever diagnosed with cancer
Diabetes	Ever diagnosed with diabetes

Table 5.3—Continued

Variable Name	Definition
E. Mental Health	
Sad	Felt sad in past 30 days
Nervous	Felt nervous in past 30 days
Restless	Felt restless in past 30 days
Hopeless	Felt hopeless in past 30 days
Effort	Felt everything was an effort in past 30 days
Worthless	Felt worthless in past 30 days
SMI	Serious mental illness (see text for definition)
F. Health Behavior	
BMI25	Body mass index ≥ 25
BMI30	Body mass index ≥ 30
Smoke now	Currently smoking
Smoke ever	Ever smoked

reporting these health conditions in the NHIS is unknown. Thus, the reader should keep these potential reporting biases in mind when interpreting the results reported below.

Some of these reporting issues can be addressed by controlling for variation in demographic characteristics. Thus, as we did with the CPS analysis in the previous section, we implement a statistical model in which we estimate the likelihood that a worker experiences one of the health conditions listed in Table 5.3 as a function of being in a protective service occupation while also controlling for age (18–39, 40–55, 56–65), education (no high school degree, high school degree, some college, college degree, advanced degree), race and ethnicity (white, black, or other), marital status (married, divorced, widowed, never married), and survey year (2001–2005).¹⁶ Estimated odds ratios, which

¹⁶ All independent variables are specified as categorical variables. We account for sampling weights, stratification, and clustering of the NHIS survey design in estimating regression coefficient and their associated standard errors via the “svylogit” command in the statistical software Stata. Sample means reported in Tables 3.5–3.9 also account for these survey design

can be interpreted in the same manner as those reported in Table 5.2 for the CPS, are reported in Table 5.10 (p. 82). In the discussion below, we first describe mean differences across occupations and then discuss whether those mean differences persist in our statistical model once we control for demographic characteristics.

Table 5.4 indicates that police officers and firefighters are less likely than non-protective service workers to be out of the labor force due to a disability (3.8 versus 5.2 percent) or to suffer some type of health condition that limits the type or amount of work they can perform (6.5 versus 8.4 percent).¹⁷ These relatively low disability and work limitation rates occur despite their relatively high injury rates. Police officers and firefighters are considerably more likely than non-protective service workers to have been injured in the past three months (3.9 versus 2.7 percent) and more than twice as likely to have been injured at work in the past three months (1.9 versus 0.9 percent). The NHIS data indicate that police officers and firefighters have the highest injury rates (both at work and otherwise) of any of the broad occupational classes considered here. There is no statistically significant difference in disability and injury rates between other protective service workers and non-protective service workers. The regression results in Table 5.10 indicate that the relatively low disability rates of police officers and firefighters become statistically insignificant once we control for demographic characteristics. However, the elevated levels of injury for police officers and firefighters are statistically significant once we control for demographic characteristics.

In Table 5.5, we see that police officers and firefighters are less likely than non-protective service workers to report being in poor or fair health (6.3 versus 8.6 percent) or to experience any chronic functional limitation (18.7 versus 22.6 percent and 17.4 versus 21.3 percent,

variables, as does the statistical test comparing the protective service and non-protective service worker means.

¹⁷ These disability rates are considerably higher than those reported in the CPS. This is likely due to the fact that our NHIS sample contains individuals who have been out of the labor force for an extended period of time, whereas the CPS sample is limited to individuals who worked in the previous calendar year. The NHIS sample is also somewhat older (age 18–65 versus 18–50). All means are weighted employing NHIS-generated survey weights.

Table 5.4
Incidence of Disability and Injury, by Occupation

Occupation	Number of Obs.	Disability Incidence (%)			
		Disabled	Work Limitation	Injured	Injured at Work
Police and fire	1,028	0.038**	0.065**	0.039	0.019**
Other protective services	562	0.057	0.092	0.026	0.009
Non-protective services	52,938	0.052	0.084	0.027	0.008
Officials and managers	7,011	0.024	0.046	0.025	0.005
Professional	7,938	0.022	0.043	0.024	0.004
Technicians	982	0.033	0.059	0.027	0.006
Sales	5,265	0.033	0.067	0.021	0.002
Clerical	3,513	0.047	0.082	0.021	0.003
Service	4,925	0.067	0.107	0.033	0.009
Farming	1,545	0.057	0.099	0.026	0.011
Precision production	10,598	0.066	0.100	0.031	0.014
Machine operators	4,327	0.078	0.114	0.034	0.015
Transportation	4,548	0.087	0.127	0.025	0.012
Laborers	2,265	0.093	0.125	0.029	0.011

SOURCE: NHIS, 2001–2005.

NOTES: Sample restricted to men age 18–65. See text for additional sample restrictions and Table 5.3 for variable definitions.

** Mean is statistically different from mean for non-protective service workers at the 5 percent confidence level. Means are weighted using NHIS-generated survey weights and statistical tests account for NHIS survey design (i.e., stratification and clustering).

respectively).¹⁸ A functional limitation is defined as having trouble with specific physical tasks (e.g., walking a quarter of a mile, walking up 10 steps, standing for two hours, carrying a 10-pound object) and engag-

¹⁸ Readers will note that the fraction of respondents reporting being in poor or fair health in the NHIS is considerably lower than the same fraction in the CPS (9.1 versus 26.9 percent for non-protective service (public safety) workers). We do not know why this would be the case. If anything, we might expect the opposite, since our NHIS sample is older than our CPS sample.

Table 5.5
Incidence of Poor Health and Functional Limitations, by Occupation

Occupation	Poor Health Incidence (%)		
	Poor Health	Functional Limitation	Chronic Functional Limitation
Police and fire	0.063*	0.187*	0.174*
Other protective services	0.105	0.217	0.209
Non-protective services	0.086	0.226	0.213
Officials and managers	0.047	0.195	0.185
Professional	0.044	0.194	0.181
Technicians	0.042	0.195	0.184
Sales	0.064	0.186	0.174
Clerical	0.080	0.236	0.222
Service	0.109	0.212	0.196
Farming	0.117	0.224	0.214
Precision production	0.102	0.258	0.245
Machine operators	0.126	0.272	0.260
Transportation	0.136	0.284	0.271
Laborers	0.128	0.222	0.207

Source: NHIS, 2001–2005. Notes: Sample restricted to men age 18–65. See text for additional sample restrictions, Table 5.3 for variable definitions, and Table 5.4 for sample sizes.

* Mean is statistically different from mean for non-protective service workers at the 1 percent confidence level. Means are weighted using NHIS-generated survey weights and statistical tests account for NHIS survey design (i.e., stratification and clustering).

ing in social activities and recreation (e.g., going shopping, attending club meetings, visiting friends, sewing, reading) without the assistance of another person. These differences between police officers/firefighters and non-protective service workers remain statistically significant when we control for demographic characteristics (Table 5.10). Other protective service workers are somewhat more likely to report being in poor or fair health than are non-protective service workers, but are roughly equally likely to report suffering a functional limitation. None

of these differences between other and non-protective service workers is statistically significant.

There is little variation in rates of pain (defined as having answered yes to the question “In the past three months, did you have [neck, leg, back, etc.] pain?”) across occupational classes (Table 5.6). We observe a somewhat lower incidence of pain among police officers and firefighters, but the differences are quite small and, as the regression results reported in Table 5.10 confirm, are not statistically significant.

Rates of specific chronic disease (defined as having answered yes to the question “Have you ever been told by a doctor or other health

Table 5.6
Incidence of Pain, by Occupation

Occupation	Pain Incidence (%)				
	Neck	Back	Leg	Face	Migraine
Police and fire	0.123	0.266	0.311	0.024	0.095
Other protective services	0.097	0.246	0.315	0.023	0.110
Non-protective services	0.128	0.266	0.287	0.032	0.108
Officials and managers	0.112	0.239	0.243	0.026	0.089
Professional	0.119	0.230	0.222	0.031	0.090
Technicians	0.102	0.215	0.246	0.033	0.105
Sales	0.114	0.255	0.238	0.031	0.096
Clerical	0.112	0.226	0.297	0.029	0.105
Service	0.117	0.246	0.276	0.033	0.120
Farming	0.112	0.273	0.292	0.030	0.108
Precision production	0.151	0.313	0.323	0.033	0.117
Machine operators	0.140	0.292	0.354	0.035	0.136
Transportation	0.157	0.315	0.343	0.036	0.120
Laborers	0.129	0.272	0.274	0.034	0.118

SOURCE: NHIS, 2001–2005.

NOTES: Sample restricted to men age 18–65. See text for additional sample restrictions, Table 5.3 for variable definitions, and Table 5.4 for sample sizes. Means are weighted using NHIS-generated survey weights and statistical tests account for NHIS survey design (i.e., stratification and clustering).

professional that you had [hypertension, heart disease, etc.]?”) also do not vary widely across occupations (Table 5.7).¹⁹ More than a fifth of police officers and firefighters have been diagnosed with hypertension and 3.8 percent with some type of heart disease, but these rates are close to and not statistically different from those reported by other workers. Police officers and firefighters are more likely than non-protective service workers to have reported being diagnosed with a heart attack (2.9 versus 2.5 percent) and to be diagnosed with heart disease (3.8 versus 2.9 percent), but these differences are not statistically significant. Rates of emphysema, asthma, ulcers, and cancer are about the same between police officers/firefighters and other workers, while rates of stroke and diabetes are somewhat lower. However, none of these differences in rates of chronic disease is statistically significant either unconditionally (Table 5.7) or conditional on demographic characteristics (Table 5.10). Other protective service workers appear to be at a somewhat elevated risk of being diagnosed with chronic disease, but these differences also are not statistically significant.

The NHIS contains a six-question screener, known as the K6 scale, designed to discriminate cases of serious mental illness (Kessler et al., 2003). The screener asks respondents to report how often (all, most, some, a little, or none of the time) they felt the following in the past 30 days: so sad that nothing could cheer them up; nervous, restless or fidgety; hopeless; everything was an effort; and worthless. Each response is scored from 0 to 4, with higher scores reflecting that the respondent experienced the symptom more frequently. Those questions can then be summed to produce an overall mental health score, and scores of 13 or more are considered possibly indicative of serious mental illness. For each of the six screener questions, we formed a dichotomous variable equal to 1 if the respondent reports having experienced the emotion in question in the past 30 days (i.e., if responded anything other than “none of the time”) and 0 otherwise. We also created a dichotomous

¹⁹ We make no attempt to correct for differential access to health care across occupations that could be correlated with the incidence of diagnoses. However, regression results reported here control for education, which is generally positively correlated with access to health care.

Table 5.7
Incidence of Chronic Disease, by Occupation

Occupation	Incidence of Chronic Disease (%)										
	Hyper-tension	Heart Disease	Angina	Heart Attack	Other Heart Cond.	Stroke	Emphy-sema	Asthma	Ulcer	Cancer	Diabetes
Police and fire	0.213	0.038	0.023	0.029	0.046	0.008	0.011	0.093	0.067	0.037	0.062
Other protective services	0.229	0.028	0.029	0.028	0.057	0.016	0.018	0.081	0.059	0.020**	0.075
Non-protective services	0.202	0.029	0.017	0.025	0.049	0.012	0.010	0.091	0.063	0.034	0.074
Officials and managers	0.222	0.032	0.016	0.021	0.052	0.009	0.006	0.094	0.057	0.044	0.072
Professional	0.190	0.021	0.011	0.016	0.052	0.006	0.004	0.097	0.050	0.041	0.059
Technicians	0.144	0.015	0.010	0.007	0.042	0.006	0.005	0.085	0.063	0.038	0.043
Sales	0.186	0.028	0.019	0.027	0.050	0.011	0.006	0.092	0.056	0.036	0.069
Clerical	0.200	0.030	0.021	0.028	0.040	0.011	0.008	0.104	0.062	0.029	0.084
Service	0.168	0.023	0.016	0.021	0.043	0.018	0.013	0.106	0.056	0.018	0.071
Farming	0.175	0.019	0.013	0.022	0.032	0.015	0.012	0.087	0.069	0.034	0.077
Precision production	0.202	0.031	0.021	0.030	0.051	0.013	0.014	0.080	0.069	0.033	0.072
Machine operators	0.236	0.037	0.019	0.034	0.053	0.017	0.013	0.076	0.081	0.030	0.092
Transportation	0.252	0.038	0.020	0.032	0.053	0.018	0.022	0.083	0.079	0.035	0.107
Laborers	0.165	0.019	0.016	0.018	0.043	0.013	0.010	0.108	0.061	0.019	0.061

SOURCE: NHIS, 2001–2005.

NOTES: Sample restricted to men age 18–65. See text for additional sample restrictions, Table 5.3 for variable definitions, and Table 5.4 for sample sizes.

** Mean is statistically different from mean for non-protective service workers at the 5 percent confidence level. Means are weighted using NHIS-generated survey weights and statistical tests account for NHIS survey design (i.e., stratification and clustering).

variable indicating whether or not the individual scores attained 13 or higher, indicating possible serious mental illness. In Table 5.8, we report differences across occupations for all six screener questions as well as the indicator for serious mental illness.

Police officers and firefighters are considerably less likely to report having experienced any of these symptoms in the past 30 days (Table 5.8), a finding that holds once we control for demographic characteristics (Table 5.10). For example, 12 percent of police officers and firefighters report having felt sad in the past 30 days, compared with 19.9 percent of non-protective service workers. For each of the individual symptoms and for the combined indicator for mental illness listed in Table 5.8, police officers and firefighters report among the lowest, and sometimes the lowest, incidence rates. Other protective service workers, on the other hand, report incidence rates that are comparable to those of non-protective service workers.

The results reported in Table 5.9 indicate that police officers and firefighters are more likely to be overweight ($\text{BMI} \geq 25$) or obese ($\text{BMI} \geq 30$) than both other protective service workers and all non-protective service workers. For example, 82.6 percent of police officers and firefighters are overweight, compared with 74.0 percent of other protective service workers and 68.1 percent of non-protective service workers. Indeed, police officers' and firefighters' rates of being overweight and obese exceed those of any other occupational group, a finding that holds after controlling for demographic characteristics (Table 5.10).

On the other hand, police officers and firefighters are significantly less likely to smoke than are non-protective service workers. About 14 percent of police officers and firefighters currently smoke and 40 percent have ever smoked, compared with 22 and 49 percent, respectively of non-protective service workers. Table 5.10 indicates that these differences persist after controlling for demographic characteristics. Smoking rates of other protective service workers are comparable to those of non-protective service workers.

It is possible that the relatively good health of police officers and firefighters does not persist at later ages. Police officers and firefighters may be naturally quite healthy, but their jobs may take a toll on

Table 5.8
Indicators of Mental Health and Possible Serious Mental Illness, by Occupation

Occupation	Responses to Individual Symptoms (%)						Possible Serious Mental Illness (%)
	Sad	Nervous	Restless	Hopeless	Effort	Worthless	
Police and fire	0.120**	0.230**	0.246**	0.040**	0.146**	0.033**	0.008**
Other protective services	0.210	0.293	0.289	0.092	0.233	0.084	0.034
Non-protective services	0.199	0.313	0.320	0.101	0.218	0.081	0.023
Officials and managers	0.147	0.300	0.310	0.064	0.184	0.051	0.014
Professional	0.154	0.353	0.342	0.074	0.207	0.055	0.010
Technicians	0.167	0.329	0.332	0.090	0.246	0.063	0.020
Sales	0.169	0.306	0.310	0.086	0.200	0.065	0.016
Clerical	0.223	0.335	0.333	0.113	0.242	0.100	0.020
Service	0.260	0.334	0.335	0.133	0.242	0.108	0.036
Farming	0.197	0.274	0.268	0.115	0.188	0.094	0.032
Precision production	0.208	0.291	0.305	0.109	0.222	0.088	0.029
Machine operators	0.243	0.324	0.327	0.123	0.229	0.092	0.030
Transportation	0.240	0.287	0.323	0.135	0.245	0.111	0.037
Laborers	0.263	0.306	0.322	0.135	0.250	0.105	0.033

SOURCE: NHIS, 2001–2005.

NOTES: Sample restricted to men age 18–65. See text for additional sample restrictions, Table 5.3 for variable definitions, and Table 5.4 for sample sizes.

** Mean is statistically different from mean for non-protective service workers at the 5 percent confidence level. Means are weighted using NHIS-generated survey weights and statistical tests account for NHIS survey design (i.e., stratification and clustering).

Table 5.9
Incidence of Health Behaviors, by Occupation

Occupation	Health Behavior Incidence (%)			
	BMI25	BMI30	Smoke Now	Smoke Ever
Police and fire	0.826**	0.342**	0.135**	0.398**
Other protective services	0.740**	0.292	0.218	0.480
Non-protective services	0.681	0.246	0.219	0.488
Officials and managers	0.731	0.248	0.142	0.437
Professional	0.647	0.208	0.091	0.354
Technicians	0.656	0.227	0.156	0.422
Sales	0.679	0.220	0.182	0.445
Clerical	0.658	0.255	0.196	0.444
Service	0.608	0.228	0.278	0.508
Farming	0.645	0.218	0.226	0.471
Precision production	0.696	0.254	0.298	0.585
Machine operators	0.694	0.264	0.294	0.574
Transportation	0.743	0.334	0.299	0.583
Laborers	0.635	0.244	0.282	0.511

SOURCE: NHIS, 2001–2005.

NOTES: Sample restricted to men age 18–65. See text for additional sample restrictions, Table 5.3 for variable definitions, and Table 5.4 for sample sizes.

** Mean is statistically different from mean for non-protective service workers at the 5 percent confidence level. Means are weighted using NHIS-generated survey weights and statistical tests account for NHIS survey design (i.e., stratification and clustering).

Table 5.10
The Effect of Occupation on Health in the NHIS: Odds Ratios
Relative to Non–Protective Service Workers

Dependent Variable	Police and Fire	Other Protective Services
A. Disability and Injury		
Disabled	0.807	0.850
Work limitation	0.831	0.898
Injured	1.407**	0.933
Injured at work	2.012*	1.021
B. Subjective Health and Limitations		
Poor health	0.796	1.037
Functional limitation	0.760*	0.890
Chronic functional limitation	0.743*	0.915
C. Pain		
Neck pain	0.920	0.736
Back pain	0.952	0.884
Leg pain	1.173	1.082
Jaw pain	0.773	0.635
Migraine	0.873	0.989
D. Chronic Conditions		
Hypertension	1.034	1.108
Heart disease	1.275	0.842
Angina	1.191	1.515
Heart attack	1.138	0.950
Other heart condition	0.925	1.157
Stroke	0.643	1.094
Emphysema	1.123	1.351
Asthma	1.032	0.835
Ulcer	1.023	0.925
Cancer	1.091	0.655
Diabetes	0.866	1.087

Table 5.10—Continued

Dependent Variable	Police and Fire	Other Protective Services
E. Mental Health		
Sad	0.585*	0.942
Nervous	0.665*	0.930
Restless	0.689*	0.864
Hopeless	0.403*	0.810
Effort	0.625*	1.020
Worthless	0.429*	0.974
SMI	0.410*	1.359
F. Health Behaviors		
BMI25	1.925*	1.423*
BMI30	1.435*	1.210
Smoke now	0.583*	0.852
Smoke ever	0.677*	0.881

SOURCE: NHIS 2001–2005.

NOTES: Each cell reports the estimated odds ratio from a logistic model of the incidence of disability (as measured by the variables listed in the first column) on occupational choice and a set of covariates described in the text above. The excluded occupational group is non-protective service workers.

* Significant at the 1 percent confidence level.

** Significant at the 5 percent confidence level. Sample restricted to males age 18–65. See text for additional sample restrictions, Table 5.3 for variable definitions, and Table 5.4 for sample sizes. Regressions employ NHIS-generated survey weights and account for NHIS survey design (i.e., stratification and clustering).

their well-being over time, leading to relatively poor health later in life. We investigate this possibility by estimating the same regressions reported in Table 5.10, but restricting the NHIS sample to men age 40–65. Those results suggest that almost all of the results reported in Table 5.10 also hold in this older sample. The notable exception is with heart disease. Controlling for demographic characteristics, the odds that older police officers and firefighters are diagnosed with a heart dis-

ease are 38 percent higher than the odds for other older workers. However, this elevated risk for heart disease should be interpreted with care, as it is statistically significant at only the 10 percent confidence level.²⁰

5.3 Discussion

Analyses of CPS and NHIS data suggest that police officers and firefighters are relatively healthy as a class. They are less likely than non-safety or non-protective service workers to report being disabled, to report poor or fair health, to have a functional limitation, or to display symptoms of serious mental illness, and their rates of pain are comparable to those of other workers. With the possible exception of heart disease in older police officers and firefighters, rates of chronic disease are comparable to those of other workers. Moreover, although police officers and firefighters are considerably more likely to be overweight than other workers, their rates of smoking are considerably lower. However, the NHIS does confirm that police officers and firefighters are much more likely to be injured on the job or otherwise than are other workers, which might help explain why the CPS indicates that they are considerably more likely to receive workers' compensation.

This elevated injury rate, though, does not seem to translate into relatively poor health over all. This finding is consistent with at least two hypotheses. First, it could be that most *nonfatal* on-the-job injuries suffered by police officers and firefighters have relatively little impact on long-term health. Second, it could be that individuals who are inherently healthier select into police and fire occupations, making them better able to recover after an injury. This second explanation is consistent with the healthy worker effect (Choi, 2000). Either explanation suggests that the high rates of workplace injury have relatively little impact on the ability of public safety employees to work. This result

²⁰ In fact, if we applied a Bonferroni adjustment, a statistical correction made to reflect the fact that when conducting multiple tests some may be significant by chance, the finding would not be significant at all.

seems somewhat surprising, and we explore it in greater detail in the next chapter.

While the results reported here provide some evidence that police officers and firefighters are relatively healthy overall, and yet have relatively high disability and worker's compensation rates, this conclusion may be biased by sample selection and reporting bias in unknown ways. The CPS and NHIS are likely to identify occupations for relatively healthy individuals, and respondents who have relatively good access to medical care might be relatively more likely to report certain types of health conditions. In order for these survey problems to affect our conclusions, it must be the case that they differentially affect public safety workers. We have no evidence on this question either way and so, while we suspect that these survey problems are not likely to substantially affect our conclusions since, we cannot be certain.

Work-Related Disability Benefit Receipt and Disability Retirement Among Public Safety Employees

It has been well established that the fatality risk of public safety occupations is higher on average than that of non-safety occupations. However, our review of the literature indicated that much less is known about differences in severity of nonfatal injuries. Of particular concern are work-related injuries that lead to permanent disability. All injuries have adverse economic and noneconomic consequences to workers, but permanent disabilities that result from workplace injuries tend to be more severe and can lead to reduced earnings years after the injury. Permanent disabilities are also more expensive to employers: Estimates suggest that workers' compensation claims involving a permanent disability cost employers twice as much temporary claims.¹ These high costs to workers and employers make permanently disabling injuries an important target of any safety intervention. Unfortunately, we know relatively little about how the disability rate due to work-related injuries of public safety employees compares with that of non-safety employees.

There are indications that occupational permanent disability is an important problem for public safety employees. In 2000, an estimated 25 percent of new firefighter retirements nationwide were dis-

¹ Specifically, in 2006, permanent disabilities accounted for 36 percent of all workers' compensation claims but 72 percent of workers' compensation benefits (Sengupta, Reno, and Burton, 2008).

ability retirements rather than regular retirements, meaning that the worker retired due to the effects of a disabling workplace injury or illness (IAFF, 2000). CalPERS data from 2004 indicate that about 40 percent of disability benefits paid to public safety employees went to those on occupational disability retirement.²

However, as reported in Chapter Two, public safety workers are much more likely to be eligible for occupational disability retirement benefits than are non-safety workers. Thus, using only data on disability retirement, it is difficult to draw any inference about how the work-related disability rates of public safety workers compare with those of non-safety workers.

The results of the previous chapter seemed to indicate that public safety employees were actually less likely to be disabled than the general population. However, while the survey data are powerful instruments for comparing the overall health of public safety and non-safety personnel, there are several reasons why the data studied in the previous chapter may not be the best for comparing rates of *work-related* disability among the two populations. The surveys are not designed to address this issue, so the questions they ask have important limitations.³ Generally speaking, in order to compare disability rates between public safety and non-safety personnel we would need data that (1) differentiate between temporary and permanent disabilities, (2) identify a workers' occupation at the time of disability onset, and (3) record the existence of a work-related disability consistently across public safety and non-safety occupations.

In this chapter, we study the frequency of work-related disabilities using data from a sample of public employees in California. Our approach is to compare the rates at which public safety and non-safety

² Public safety employees in CalPERS are mostly made up of local police officers and firefighters, but also include other workers, such as state highway patrol officers and correctional facility officers.

³ For example, the survey makes no distinction between work-related disability and non-work disability, so it provides no direct measure of the incidence of a disability that was caused by work. In addition, the questions on disability income are not detailed enough to distinguish between temporary or permanent disability income, or to identify disability retirement.

employees file for permanent partial disability benefits in the state's workers' compensation system. Workers injured on the job who are permanently disabled as a result of their injuries are eligible for PPD benefits, and the eligibility rules for permanent disability benefits in California are comparable among public safety and non-safety personnel. Thus, with this data set we can compare the rates at which public safety and non-safety occupations report a work-related injury and how often these injuries result in a permanent disability claim.

An important question in this analysis will be how to interpret any differences across occupations. Ultimately, our data represent rates of claiming for disability benefits, which will only approximate rates of work-related disability to the extent that claiming behavior is consistent across occupations. However, differences in injury compensation can distort incentives to file for both workers' compensation and retirement benefits. We discuss these incentives and their implications later in this chapter.

6.1 Data and Methods

For this study, we obtained data on workers from 29 different public employers in California. The employers correspond to the city and county employers who provided data in the original RAND self-insurance study (Reville et al., 2001). We focused on cities and counties because these employers were most likely to employ both public safety workers and workers in other occupations (as opposed to a public agency, such as a school system). These data consist of individuals making a workers' compensation claim for a lost-time injury with a claimed injury date from 1991 through 1996. Specifically, these claims include TTD and PPD claims and exclude medical only, PTD, and deaths. There are two key limitations to the workers' compensation data provided to us: (1) no information is provided about uninjured workers, and (2) the occupation of injured workers is not recorded. This is problematic because it both prevents us from calculating disability or injury rates and because it prevents us from distinguishing those rates in the public safety and non-safety occupations.

To overcome these limitations, we link the workers' compensation data to administrative data on retirees provided to us by CalPERS, which contains data on individuals employed at the same municipalities and who were not injured and includes information on occupation. Thus, by linking the workers' compensation data to the disability retirement data, we complete the necessary information to differentiate disability rates across occupations. The CalPERS data include all individuals who (1) retired at one of the reporting employers from 1991 through 2006 and (2) were active in the CalPERS system as of 2001. The former means that anyone still working as of 2006 would not be in the data, while the latter means that neither would anyone who retired but left the system prior to 2001 (this could occur, for example, if the worker retired but subsequently died prior to 2001).

The CalPERS sample includes 8,267 male workers who retired from 1991 to 2006. Of these, 1,864 (23 percent) are categorized as police officers and 1,352 (16 percent) are categorized as firefighters. For the remaining 5,051 (61 percent), no additional information on occupation is provided, so these are simply classified as "other." Note that, as before, we restrict the data set to males because males and females often exhibit different labor market behavior and police officers and firefighters are disproportionately male. If we did not drop females from the analysis, this might generate differences between the public safety and non-safety personnel that are attributable to differences in the gender distribution.⁴

In Table 6.1, we provide summary statistics on the number and types of retirements in the data by occupation. The most obvious finding from the table is the high rate of disability retirement among public safety employees. Approximately 37.3 percent and 30.6 percent of police officers and firefighters, respectively, take an industrial disability retirement. The other disability category accounts for very few retirements among public safety employees, just 1 percent or so. For the other, non-safety occupations, industrial disability accounts for just 3.7 percent

⁴ The sample sizes of female safety employees were too small to consider them separately. In the data, just 6 percent of police officers and 2 percent of firefighters are female, compared with 45 percent of the other public employees.

Table 6.1
Distribution of Retirements by Type and Occupation, California Public Employees, 1991–2006 Retirees

Occupation	Industrial Disability (%)	Other Disability (%)	Service (%)	Number of Observations
Police	37.3	1.1	61.6	1,868
Firefighters	30.6	0.7	68.7	1,353
Other	3.7	7.0	89.3	5,039
All California public employees	15.7	4.6	79.7	8,260

and other disability accounts for 7.0 percent of retirees. On the surface, this would indicate an elevated disability rate among public safety employees, but the enhanced eligibility for public safety employees in California prevents us from drawing any meaningful conclusion from this difference.

We match the CalPERS retirement data with data on workers' compensation claims from the reporting government agencies using the Social Security number of the employees. The match rate is expected to be less than 100 percent, for several reasons. One is that not everyone who retired will have filed a workers' compensation claim. Also, as described above, the retirement data are limited to individuals who retired at any point from 1991 through 2006. Any individual who did not retire in CalPERS at one of the reporting employers over this time period will not match.⁵ Similarly, any individuals who retired but who then died or otherwise left the CalPERS system will also fail to match. In addition, there may be some matches that do not occur because of coding errors in the Social Security number, though this is likely a small fraction of cases. Errors in the match rate will only affect our analysis if they differ systematically by occupation in such a way as to

⁵ The retirees are recorded under the employer they worked for at the date of retirement, and CalPERS data were only provided for the workers who are recorded as retiring at one of the reporting agencies. Thus, if a worker was injured while working for Employer A and then transferred to Employer B and subsequently retired, and B was not one of the reporting agencies, the worker would fail to match.

increase the observed disability rate of public safety employees. While we have no reason *ex ante* to believe that this is true, we cannot rule it out with any certainty.⁶

The sample of injured workers matched to retirement data includes 2,429 male workers. About 28 percent of these were firefighters, 34 percent were police officers, and the remaining 38 percent were in other occupations for public employers. The fraction of public safety workers in the matched sample (specifically, the retired workers who we also observe in the workers' compensation data) is much greater than that in the full population of public employees because public safety workers are more likely to be injured on the job and more likely to have retired during the specific period of time covered by our data. Unsurprisingly, since we are focusing on retirees, the age distribution is also skewed toward older workers. In our sample, just 12 percent were under 40 at the time of retirement, while 32 percent were between 40 and 50, and 56 percent were over 50. While this obviously limits the representativeness of this sample, we do not have any reason to believe it will generate systematic biases in the *difference* in the disability rate between occupations (particularly when we control for age).

In most of our analyses, we limit the sample to retirees who retired during the time period from 1992 to 1997. Because our workers' compensation data are for 1991–1996, restricting the sample to 1992–1997 retirements helps us to control for the fact that individuals who retired in later years are more likely to have made a workers' compensation claim prior to retirement but that we do not observe. Nevertheless, qualitatively, the findings are similar whether or not we restrict the sample.

The methods we use in our analysis are straightforward: We calculate the fraction of workers' compensation claimants that receive permanent disability benefits and compare them across occupations. We compare rates of filing any injury claim as well as filing for permanent disability benefits across police officers, firefighters, and other occupations. We also break the sample into different age groups to examine

⁶ Appendix B provides some additional information about the apparent quality of the match.

whether the different occupations become more or less susceptible to disability as they age.

There are three critical assumptions underlying the interpretation of differences in disability claiming rates as indicating differences in “true” work-related disability rates. The first is that differences in workers’ compensation claiming rates across occupations correlate strongly with differences in injury rates. We might question this assumption, given that a large fraction of work-related injuries go unreported (e.g., see Biddle and Roberts, 2003), so a worker might have been injured without ever filing a workers’ compensation claim. This is potentially problematic because the higher levels of TTD benefits provided by California Labor Code 4850 give public safety employees increased incentives to report injuries and file claims. However, public safety employees do not have extra incentives to file for PPD benefits, because the benefit levels and eligibility rules are the same. Therefore, we expect that any differences in claims rates across occupations should bias us *against* finding elevated disability rates among public safety employees, because claims that go unreported tend to be minor claims that are less likely to result in PPD payments (Lakdawalla, Reville, and Seabury, 2007).⁷

Another important assumption is that the receipt of permanent disability benefits is a reliable indicator of a work-limiting disability. As Reville et al. (2005) discuss, the California system for evaluating permanent disabilities that was in place at this time was controversial, and critics often argued that it relied too heavily on subjective factors that made it vulnerable to fraud. Nevertheless, Reville et al. also find empirical evidence that (1) workers with PPD benefits earn lower wages and are less likely to work and (2) the disability severity evaluations in the California system appeared to predict the magnitude of lost earnings experienced by injured workers.⁸ This suggests that although the

⁷ In other words, the claims that are more likely to be reported because of the incentives provided by California Labor Code 4850 are less likely to involve PPD, so any bias in the disability rate should be to increase the denominator more than the numerator for safety employees. Thus, we are biased against finding an elevated disability rate.

⁸ Specifically, Reville et al. (2005) estimate the lost earnings that injured workers experience subsequent to their injury and compare them with disability ratings, the numeric evalu-

presence of PPD benefits may not be a perfect measure of disability, the two should at least be closely correlated.

Finally, we must assume that PPD claims are evaluated the same across public safety and non-safety occupations. In particular, we need to assume that there are not systematic differences in injuries that make them easier to diagnose or establish as work-related for the public safety occupations. In some cases, this assumption seems particularly strong; it seems straightforward to determine the work-relatedness of an injury from an assault or a traffic accident. However, our earlier findings do suggest that differences between public safety and non-safety occupations in the types of injuries are more pronounced for fatal than nonfatal injuries, which appear to be dominated by musculoskeletal disorders.

Ultimately, whether these assumptions hold or not is unknown. If they do, then our analysis provides information about how injuries and injury severity differ by age and occupation. If not, then the findings are more difficult to interpret, because they reflect some combination of injury and severity with differences in claiming behavior. When we discuss the policy implications of what follows, we will consider the possibility that these assumptions are not valid and that the results ultimately reflect differences in claiming.

6.2 Permanent Disability Benefit Receipt, by Occupation

Our first step is to compare the rate at which public safety workers made a workers' compensation claim relative to other public employees. Table 6.2 reports the percentage of our sample that filed any TTD or PPD claim during the time period, the percentage of those that reported a workplace injury that also received PPD benefits, and the unconditional percentage that made a claim with PPD. The table compares these percentages for police officers, firefighters, and other occu-

ation of disability severity assigned in the California system. They find that injured workers have significant earnings losses, approximately 15 percent on average. Additionally, workers with higher disability ratings were found to have higher earnings losses.

Table 6.2
Injury and Permanent Disability Receipt, by Occupation, California Public Employees, 1992–1997 Retirees, Age 50 and Older at Time of Retirement

Occupation	Percentage of Sample with a TTD Claim	Percentage of TTD Sample with PPD Benefits	Percentage of Sample with any PPD Claim
Police	41.8*	59.9*	24.9*
Firefighters	51.8*	52.2	26.9*
Other	17.3	46.6	7.9

* The difference from the other occupations is statistically significant at the 10 percent level or better.

pations, with an asterisk marking that the difference from the same percentage for the non-safety occupations is statistically significant at the 10 percent level or better.⁹

Table 6.2 indicates that public safety retirees are considerably more likely to have made a workers' compensation claim prior to retirement. Just 17.3 percent of non-safety occupations are observed making a claim, compared with 41.8 percent for police officers and 51.8 percent for firefighters (both differences are statistically significant). Of the claims that are made, the differences in the likelihood that it will include PPD benefits between the public safety and non-safety occupations are less pronounced. For non-safety occupations, 46.6 percent of claimants received PPD, compared with 52.2 percent of firefighters and 59.9 percent of police officers.¹⁰ Only the difference between police officers and non-safety occupations is significant.

The higher injury rate and (weakly) higher disability rate conditional on a claim combine to make the unconditional likelihood that a

⁹ Significance at the 10 percent level is a less restrictive standard than the analyses in the previous chapter; we adopt the lower standard because of the smaller sample sizes for this analysis.

¹⁰ On the surface, these seem like very high rates of permanent disability conditional on a lost time case. This is likely due to the fact that we are focusing on retirees, and disability retirees are more likely to have been injured. Additionally, it is worth keeping in mind that the data do come from California, where close to 40 percent of lost time claims result in PPD over this time period (Reville et al., 2005).

retiree was permanently disabled prior to retirement substantially higher for public safety employees. Approximately 24.9 percent of police officers and 26.9 percent of firefighters in the sample made a claim with PPD, compared with just 7.9 percent of public employees in the non-safety occupations. Both differences are statistically significant.

It is possible that public safety workers might be more susceptible to work limitations because of the physically demanding nature of their work. If this were so, we might expect the differences in disability rates between public safety and non-safety workers to be more pronounced at older ages, if the older workers find it more difficult to meet the physical job requirements. Table 6.3 compares the frequency of workers' compensation and PPD claims by occupation and age at the time of retirement. The top panel reports the percentages for a given age and occupation category with any claim, while the bottom reports the percentage with a PPD claim. The table uses four different categories of retirement age: under 40, 40–50, 50–60, and 60 and over.

Interestingly, Table 6.3 indicates that the only clear differences in the injury or disability rates come from the 50–60 age category. When

Table 6.3
Percentage of Retirements Preceded by a Workers' Compensation Claim, by Occupation and Retirement Age, California Public Employees, 1992–1997 Retirees

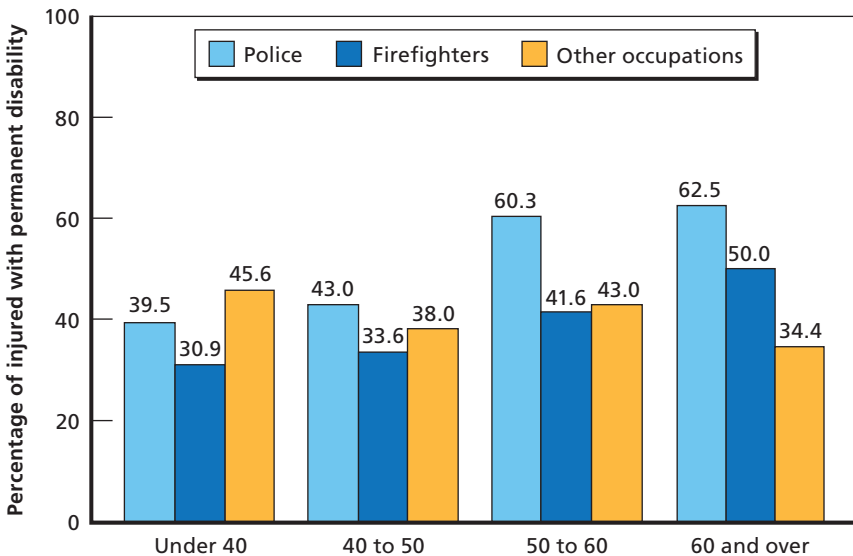
Occupation	Retirement Age			
	Under 40	40–50	50–60	60 and Over
Any Injury				
Police	40.4	36.6	26.6*	8.9
Firefighters	37.5	51.5*	29.9*	14.3
Other	48.8	31.4	11.5	6.7
Permanent Disabling Injury				
Police	25.5	18.8	16.7*	6.7
Firefighters	37.5	27.3	16.7*	10.7
Other	29.3	17.1	6.5	2.6

* The difference from the other occupations is statistically significant at the 10 percent level or better.

workers are younger or older than this group, the differences between public safety and other employees are usually small and in almost every case fail to achieve statistical significance. However, for the age 50–60 category, police officers and firefighters are both more than twice as likely to report a workplace injury and almost three times more likely to have a permanent disability claim. The magnitudes of the differences for the 60 and over category are somewhat similar, so in those cases the lack of significance may be related to the smaller sample sizes (the 50–60 category is the largest group in our sample).

We can also compare the rate at which retirees in our sample claimed permanent disability benefits by age and occupation. Figure 6.1 illustrates the percentage of injuries that include PPD benefits for police officers, firefighters, and other occupations for the same four age categories used in Table 6.3. An important distinction, though, is that here we are considering injured workers, so the age categories are based on the age at the time of injury (not retirement).

Figure 6.1
Percentage of Retirees That Received Permanent Disability Benefits, by Occupation and Age at Injury



The figure indicates a clear difference in the age-disability profile for public safety employees and other public employees. Both police officers and firefighters are more likely to receive PPD in each successive age category. This ranges from 39.5 percent for police officers under 40 to 62.5 percent for those 60 and over. Similarly, 30.9 percent of injured firefighters under 40 receive PPD, compared with 50.0 percent of injured firefighters 60 and over. However, for injured public employees in other occupations, there is either no clear pattern or it even declines at older ages. These results indicate that either older public safety employees experience more severe injuries, or that the injuries they experience for a given severity level are more likely to disrupt their ability to work.

The results in this section clearly establish that public safety employees claim a work-related disability at a higher rate than employees in non-safety occupations.¹¹ The differences also appear most pronounced at older ages. If our assumptions hold and PPD benefit receipt is a good proxy for an actual disability, it appears that public safety employees do experience a truly elevated risk of a work-related disability on average, and particularly as they approach retirement age.

6.3 Incentive Effects of Injury Compensation

One concern that employers often have with workers' compensation is that the benefits create adverse incentives against returning to work. Researchers have confirmed that there is some truth to this, with past studies showing that an increase in disability benefits of 10 percent is associated with an increase in the time out of work by injured workers of approximately 3 percent to 4 percent (Meyer, Viscusi, and Durbin,

¹¹ Our findings are actually not wholly inconsistent with the results from the NHIS data in Chapter Five. We took the sample of workers who report experiencing a work-related injury and regressed a self-reported disability or work limitation as a function of being a public safety employee, while conditioning on the same set of demographics as before. The regression results indicate that police officers and firefighters are associated with approximately a 20-percentage-point increase in the likelihood of being disabled after an injury (significant at the 10 percent level).

1995). Similarly, others have found that higher disability benefits increase the number of claims that are filed (e.g., see Krueger, 1990). Given the high level of injury compensation available to public safety employees in California and other parts of the United States, it is natural to suspect that this could increase both the number and duration of work-related injury claims.¹² With the strict staffing requirements that are often associated with public safety work, this could place strain on local budgets and raise the cost to taxpayers of providing public safety.

While evaluating the labor supply impact of injury and disability compensation is beyond the scope of this study, it is instructive to examine different policies that address the issue. One approach that has been taken is to provide more generous benefits for a fixed period of time, after which benefits revert to the statutory level for non-safety employees. An example of this is California Labor Code 4850, which restricts the full salary replacement offered to public safety employees to one year. Another approach is to limit the increase in compensation to injuries resulting from specific job actions or risk. For instance, Florida has provisions allowing full salary replacement specifically for police officers who are injured as a result of an assault. Similarly, some municipalities were found to have clauses restricting full income replacement to cases involving a “heroic action” (Reville and Seabury, 2000). These provisions appear to be different attempts at striking a balance between, on the one hand, offering public safety employees special compensation for the risks they face and, on the other hand, the adverse labor supply incentives, and associated costs, that such compensation can generate.

In California, there have been other concerns raised about the conjunction of workers’ compensation benefits and the disability retirement system. In 2004, the *Sacramento Bee* broke a story about a

¹² It is important to distinguish between claims frequency and duration responding to financial incentives from fraud. We typically think of fraud as an employee filing a workers’ compensation claim when he or she is not really injured. However, there is some evidence that filing for a claim is costly (hence the low filing rates found by Biddle and Roberts, 2003), so increasing the amount of compensation available could increase both the filing rate and duration of claims for perfectly legitimate injuries.

phenomenon referred to as “Chief’s disease,” in which as many as 80 percent of high-level officers in the California Highway Patrol (CHP) retired on disability retirement (Hill and Korber, 2004). Rank-and-file officers took disability retirement less frequently, but still accounted for 60 percent of retirements. The CHP confirmed the findings with an internal investigation, and made recommendations for an overhaul of the disability retirement system. CHP also found reason to believe that at least some of the retirements in question were fraudulent, in the sense that they did not involve an actual disability. A related concern was raised in Los Angeles County, where 60 percent of firefighter retirements from 2001 to 2003 were preceded by a workers’ compensation claim in the previous year (Anderson, 2004). Such concerns are not limited to California. In January of 2008, the *Boston Globe* reported that over 100 firefighters in the Boston Fire Department were manipulating the disability retirement system by filing a workers’ compensation claim while on temporary assignment at a higher pay grade so as to enhance their pensions (Robinson and Nankin, 2008).

The data studied in this chapter on retirements from local public agencies in California do not directly address the issue of fraud in disability retirement, because they provide no means to assess the legitimacy of any particular claim. The findings of Chapter Five that suggested public safety employees did not experience any elevated disability rates could certainly heighten concerns that the eligibility standards left room for abuse. The lack of strong evidence supporting elevated rates of chronic disease among public safety employees could also raise concerns that the presumptions discussed in Chapter Two could lead to diseases being falsely classified as work-related. On the other hand, the results of this chapter indicate that public safety employees become disabled at a much higher rate after an injury, particularly as they become older. Ultimately, to establish whether eligibility for disability retirement should be tightened requires more information than is currently available on the work causality of disability and chronic disease.

We can make some simple comparisons as to the possible magnitude of these problems within our sample. Table 6.3 indicates that the fraction of public safety employees at or near standard retirement ages making a workers’ compensation claim prior to retirement is approxi-

mately 26–30 percent.¹³ This is much lower than the rate found among Los Angeles County firefighters, and is only somewhat higher than the BLS Survey of Occupational Injuries and Illnesses estimates that place the average injury rates at about 20 percent per year for local police officers and firefighters in California (BLS, 2008b). The data reported in Table 6.1 also indicate that the percentage of retirees claiming disability retirement is below 40 percent for local police officers and firefighters, substantially less than at CHP. This suggests either that the problems of abuse discussed above are not as common in the municipal agencies considered in this sample, or that they represent a more recent phenomenon primarily involving those retiring after 1997.

6.4 Discussion

While there is little question that police officers and firefighters experience job-related injuries at higher rates than workers in non-safety occupations, there is relatively little data on how rates of work-related disability vary across occupation. Using linked workers' compensation and disability retirement data from a sample of local public agencies in California, this chapter compared the claiming rates for workers' compensation permanent disability benefits of police officers and firefighters with those of non-safety employees. The findings indicate that public safety employees appear much more likely to experience a permanent disability, particularly if they are injured at older ages. In many cases, it is possible that these disabilities may not be so severe as to preclude them from working in other, non-safety occupations.¹⁴ This

¹³ While this may be somewhat of an underestimate, due to errors in matching, the match rate would have to be extremely poor to explain these low rates if there really was widespread and systemic abuse of the system for these workers at these employers during this time frame.

¹⁴ For instance, in the roundtable discussions described in Chapter Three, it was frequently noted that for a firefighter to be returned to duty, he or she must be able to perform any of the duties normally required of a firefighter. This includes activities such as carrying a heavy fire hose up a ladder. It is easy to imagine scenarios in which a person with a relatively minor disability may be precluded from such activities, but still be able to work in a non-safety occupation.

may help explain why we observe high rates of reported disability and disability retirement among public safety employees despite the findings from the national survey data that safety officers are less likely to be disabled overall.

One implication of our findings is that optimal safety interventions should consider the age of the target population. We found that the elevated disability rates of injured workers were driven largely by older workers, particularly among firefighters. This suggests that programs that successfully prevent and reduce the severity of injuries among older public safety workers could have the biggest impact on disability and disability retirement. From the standpoint of reducing employer costs, this is true whether the differences in disability rates we observed were due to differences in “true” disability or simply differences in claiming behavior across occupations. However, if the differences were driven by claiming behavior, then policies reforming claim management and review of disability claims by public safety employees could be more effective than actual workplace safety interventions.

Unfortunately, our data were not able to address a central concern of the public, the extent to which disability retirement rates provide compensation to truly needy, disabled public safety employees. Our results are at least suggestive that public safety employees face a legitimately higher risk of being disabled, and the risks appears to be increasing at older ages. Further work on this subject would need to combine data on disability retirement and workers’ compensation claims with more detailed accounts of the nature and severity of the injuries that they experience.

Conclusions and Policy Implications

This study combined a literature review with data analysis and qualitative methods to address a number of issues involving the health and safety of police officers, firefighters, and, to a lesser extent, other public safety employees. The literature review focused on characterizing what is currently known about the work-related injuries and illnesses most commonly associated with public safety employees. Our qualitative analysis identified some practical issues and priorities for existing safety and health interventions targeting police officers and firefighters. Our data analysis centered on comparing various health outcomes for public safety and non-safety personnel. One part of this analysis used national survey data to compare the rates of chronic disease and disability of public safety employees with those of other types of employees. The other part used administrative data to compare rates of job-related injury and disability. Here, we highlight the implications of our findings for policies designed to improve the health and safety of public safety employees.

The first salient finding is simply a need for better surveillance of injury data, particularly for injuries to law enforcement and emergency medical personnel. Data on injuries for firefighters are more widely available, but even there the most detailed data tend to focus primarily on fireground injuries, which are clearly important but account for just half of all injuries. Improved data could help researchers better identify the most prevalent injuries and their root causes for different types of public safety employees engaged in different activities. It would be particularly beneficial to collect data in such a way that it

was not influenced by compensation mechanisms or reporting incentives, to aid in the evaluation of the job-relatedness of different conditions. Additionally, improved monitoring capabilities for departments themselves could help them to identify trends and alter policies more quickly and efficiently.

The design and targeting of safety and health promotion efforts could also be improved by better monitoring of the types of situations and injury causes that lead to the most severe and disabling injuries. Most existing injury data for public safety employees, for example, give little insight into injury severity for nonfatal injuries. Similarly, disability retirement data provide little or no information about the type or cause of the incident or condition leading to disability. Such data would allow future research to identify the situations and conditions most likely to lead to severe and disabling injuries, which could then be used to prioritize interventions. This could also help monitor possible abuse of the system, for example, by tracking anomalies in the rates of disability retirement that did not appear to correspond to any perceptible change in the rates of injury known to lead to disability.

In addition to improved surveillance systems, our roundtable discussions identified several other areas that were thought to be potentially fruitful areas for safety intervention. Proper training is viewed as potentially a very strong tool for improving safety. Training for firefighters was thought to be a useful mechanism for offsetting the inexperience that results from the decline in the number of fires that has occurred as a result of improved prevention. Improved or continuing vehicle training could potentially benefit police officers and volunteer firefighters, two groups facing a particularly high risk of injury or death from automobile injuries. However, one potential drawback of training is that it can be both time-consuming and expensive.

Some other areas that emerged as potentially useful targets include increased information analysis and sharing, strong safety messages from department leadership, and improvements to protective equipment. For example, improving compliance with seat belt rules and regulations could have a substantial impact on the number of vehicular

fatalities in most safety occupations,¹ and promoting the use of body armor could help reduce fatalities among police officers. There was also a common perception that cultural changes promoting social norms that placed a higher emphasis on safety could be particularly important. However, there was also a perception that it would be difficult to develop a policy that could mandate such changes.

One goal of our analysis was to examine how existing safety intervention priorities appear to match up with the risks that public safety employees are exposed to. We found that safety intervention efforts were strongly oriented toward fatality risks. The most intensive efforts, particularly in the fire service, appeared directed toward reducing the risk of heart attacks. These efforts appeared to be fueled primarily by the observation that heart attacks account for approximately half of all job-related firefighter fatalities. However, it is difficult to compare the rates of job-related heart disease between public safety employees and other workers, because the presumptions that heart disease is job-related for public safety employees necessarily drives up the counts of job-related injuries. Our analyses using national survey data confirmed that public safety employees are more likely to be obese and might experience an elevated risk of heart disease. Still, further work is needed to establish the extent to which the heart attack risk for firefighters and police officers is truly elevated over other occupations in a causal manner attributable to job-related conditions.

Another important priority among police officers and firefighters is the need to reduce their incidence of strains, sprains, and musculoskeletal disorders, which are by far the leading cause of nonfatal injuries. Unfortunately, it is not clear whether existing efforts will have a noticeable effect. The existing efforts that seem most likely to affect these kinds of injuries are the health and wellness programs designed to reduce the risk of heart disease. It is possible that such programs could promote strength, physical fitness, and flexibility, generating a protective effect against accidental injuries, but there is little evidence

¹ However, the roundtable discussions indicated that, in some cases, compliance could require engineering changes. For example, the lack of compliance for police officers was partly attributed to discomfort caused by the belts they are required to wear.

as to the possible size of an effect. In general, despite strong advocacy and support for numerous safety and health promotion efforts in public safety, there is little evidence demonstrating the benefits of these efforts. More detailed examination of the effectiveness of different interventions would improve the ability to select and implement appropriate programs and reduce injuries.

Reducing the number of strains and sprains could potentially reduce the number of disability retirements among public safety employees. We found that both firefighters and police officers become more susceptible to disability as they age, in the sense that they are more likely to claim permanent disability benefits after an injury at older ages. The same did not appear to be true for non-safety occupations, which seems at least partly due to the higher physical demands of public safety occupations. While our data did not allow us to determine whether or not the injuries that resulted in permanent disabilities were primarily musculoskeletal injuries, it seems likely given that they are the dominant injury type leading to workers' compensation claims. These findings suggest that policies that successfully prevent injuries and alleviate the impact of injuries on the ability to work (say, by improving employees' options for modified work) for older public safety employees could help curb employer costs of disability and disability retirement.

There were several limitations to our study that are important to consider. First, the bulk of our study focused on police officers and firefighters, with only a limited amount of time devoted to EMS responders and corrections officers. While important, police and fire represent only part of the wide range of activities charged with protecting the public, and each occupation might come with a completely different set of factors that influence its risk. Additionally, much of our analysis focused on data from or departments in California. To the extent that institutional, demographic, and other important characteristics differ in other parts of the country, our findings may not be fully representative. Finally, perhaps the most important limitation to our study is that of scope: This study did not, nor was it intended to, evaluate any specific interventions designed to protect public safety employees. Despite these limitations, we feel that the findings of this study provide crucial

information to policymakers about the nature of the occupational hazards that public safety employees face and the challenges and opportunities in alleviating these risks.

Roundtable Discussion Protocol

A. Operational environment

- a. Please describe the various activities department members engage in (e.g., training, responding to various classes of incidents, patrolling, inspecting, etc.) and the environments in which these activities take place.
- b. Please approximate the fraction of work time spent in each major activity type.
- c. What is the work shift schedule?
- d. How many people per engine and ladder company (fire)?
- e. How many people per patrol car (police)?

B. Safety and health risks

- f. Our past research shows the most common types of moderate to severe injuries are:

Service	Most Common Nonfatal	Most Common Fatal
Fire	Physical stress/overexertion Exposure Fall/slip/jump Struck by/contact with	Physical stress/overexertion Lost/caught/trapped/exposed Vehicles
EMS	No data	Vehicles
Police	Assaults Physical stress/overexertion Falls Vehicles	Assaults Vehicles

- g. For each type of injury, please elaborate on
 - i. What activity are workers engaged in when this type of injury occurs?
 - ii. What environment was the worker operating in when this type of injury occurs?
 - iii. What factors lead to the various injuries?
 - iv. Which, if any, of these factors can be controlled?
 - v. Are the contributing factors
 - 1. Individual factors (e.g., experience, behavior, physiology)
 - 2. Workplace factors (e.g., equipment, training, operating procedures, management/leadership decisions)
 - 3. Environmental factors?

C. Safety and health promotion initiatives

- h. Several initiatives have been implemented to help promote safety and health among public safety workers. These include:
 - i. Fire Service Joint Labor Management Wellness-Fitness Initiative
 - ii. National Fallen Firefighters Foundation's "Everyone Goes Home" Life Safety Initiatives
 - iii. Law Enforcement Stops and Safety (LESS)
 - iv. The National Firefighter Near-Miss Reporting System
 - v. The annual fire service "Stand-down For Safety" day
- i. Does your department participate in these or other initiatives?
 - i. Why or why not?
 - ii. If so, how?
- j. How well are they working? What are their strengths and weaknesses?

- k. How are worker injury data monitored, archived, and analyzed?
- l. What other initiatives has your department implemented or considered?
- m. What do you think would help?; what would you like to try? (either within your department or on a larger scale)

Assessing the Quality of the Match Between the Workers’ Compensation and Disability Retirement Data

Some information on the quality of the match between workers’ compensation data and disability retirement data can be obtained through examination of the match rate by different characteristics of the workers. For instance, workers who were older at the time of injury should be more likely to have retired in the subsequent 10–15 year period after the injury. Similarly, workers who were injured and who do match to retirees should be more likely to receive disability retirement. Both of these hypotheses can be tested with the data.

Table B.1 examines whether the percentage of workers with a workers’ compensation claim that match to the retirement data is indeed increasing in age. The age categories considered are workers under 40, workers 40–50, and workers over 50, all evaluated at the

Table B.1
Percentage of Workers with a Workers’
Compensation Claim Matching to the
Retirement Data, by Age at Time of Injury

Age Category	Percentage Matched	Number of Observations
Under 40	5.7	8,740
40 to 50	19.0	6,881
50 and over	24.4	4,809
Total	14.6	20,430

time of injury. The latter two categories should be much more likely than the first to have retired in a 10–15 year period. Table B.1 confirms that the match rate is higher for the older workers. Those injured while they were under the age of 40 at the time of injury matched at a low rate, less than 6 percent. However, those who were 40–50 at the time of injury matched at a 19 percent rate, and those over 50 matched at a 24.4 percent rate.

While the match rate increases with age, as we expected, it is worth noting that overall rate is quite low. Workers age 50 or older in 1991–1996 should be into their 60s by 2006, suggesting that we might expect more than 25 percent to have retired. Overall, it seems likely that the data underestimate retirement rates conditional on a workers’ compensation claim, though by how much is impossible to say.

Our second hypothesis, that the match rate should be higher for those who take disability retirement, is examined in Table B.2. This table compares match rates conditional on retirement based on the type of retirement: service retirement, industrial disability, or other disability. The table confirms that matching is more likely for workers who claim a disability retirement. Additionally, the match rates for disability retirees, particularly industrial disability, are actually quite high. Workers retiring with industrial disability match at a 66.7 percent rate, while those retiring on ordinary disability match at a 44.5 percent rate. Conversely, those retiring on a service retirement match at just a 16.9 percent rate. This table suggests that matches conditional on retirement should be fairly reliable.

Table B.2
Percentage of Retirees Matched to the Workers’
Compensation Data, by Type of Retirement

Type of Retirement	Percentage Matched	Number of Observations
Industrial Disability Retirement	66.7	1,471
Ordinary Disability Retirement	44.5	687
Service Retirement	16.9	10,439
Total	24.2	12,597

References

- American Medical Association (2000). *Guides to the Evaluation of Permanent Impairment, Fifth Edition*. Chicago, IL: American Medical Association.
- Anderson T (2004). Retiring firefighters filing for workers' comp raises doubts, *San Diego Union-Tribune*, December 13, 2004.
- Austin CC, Wang D, Ecobichon DJ, and Dussault G (2001a). Characterization of volatile organic compounds in smoke at municipal structural fires, *Journal of Toxicology and Environmental Health Part A*, 63(6): 437–458.
- (2001b). Municipal firefighter exposure groups, time spent at fires and use of self-contained-breathing-apparatus, *American Journal of Industrial Medicine*, 40(6): 683–692.
- Banauch GI, Hall C, Weldon M, Cohen HW, Aldrich TK, Christodoulou V, Arcentales N, Kelly KJ, and Prezant DJ (2006). Pulmonary function after exposure to the World Trade Center collapse in the New York City Fire Department, *American Journal of Respiratory and Critical Care Medicine*, 174(3): 312–319.
- Baris D, Garrity TJ, Telles JL, Heineman EF, Olshan A, and Zahm SH (2001). Cohort Mortality Study of Philadelphia Firefighters, *American Journal of Industrial Medicine*, 39: 463–476.
- Bates MN (2007). Registry-based case-control study of cancer in California firefighters, *American Journal of Industrial Medicine*, 50(5): 339–344.
- Baumgardt-Elms C, Ahrens W, Broman K, Boikat U, Stang A, Jahn I, Stegmaier C, and Jockel KH (2002). Testicular cancer and electromagnetic fields (ENIF) in the workplace: Results of a population-based case-control study in Germany, *Cancer Causes and Control*, 13(10): 895–902.
- Berkowitz M and Burton J (1987). *Permanent Disability Benefits in Workers' Compensation*, Kalamazoo, MI: WE Upjohn Institute for Employment Research.
- Biddle JE and Roberts K (2003). Claiming behavior in workers' compensation, *Journal of Risk and Insurance*, 70(4): 759–780.

BLS—See U.S. Department of Labor, Bureau of Labor Statistics.

Bogucki S and Rabinowitz PM (2004). Occupational health of police and firefighters, in Rosenstock L and Cullen MR (eds.), *Clinical Occupational and Environmental Medicine* (2nd Edition), Philadelphia, PA: WB Saunders.

Breckenkamp J, Berg G, and Blettner M (2003). Biological effects on human health due to radiofrequency/microwave exposure: A synopsis of cohort studies, *Radiation and Environmental Biophysics*, 42(3): 141–154.

Byczek L, Walton SM, Conrad KM, Reichelt PA, and Samo DG (2004). Cardiovascular risk in firefighters: Implications for occupational health nurse practice, *American Association of Occupational Health Nurses Journal*, 52(2): 56–76.

California Public Employee Retirement System (2008), homepage. As of October 30, 2008:

<http://www.calpers.ca.gov/>

Caux C, O'Brien C, and Viau C (2002). Determination of firefighter exposure to polycyclic aromatic hydrocarbons and benzene during fire fighting using measurement of biological indicators, *Applied Occupational and Environmental Hygiene*, 17(5): 379–386.

Centers for Disease Control and Prevention (2006). Fatalities among volunteer and career firefighters—United States, 1994–2004, *Morbidity and Mortality Weekly Reports*, 55(16): 453–455. As of October 30, 2008:

<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5516a3.htm>

——— (2008). National Center for Health Statistics, homepage. As of October 31, 2008:

<http://www.cdc.gov/nchs/nhis.htm>

Choi BCK (2000). A technique to re-assess epidemiologic evidence in light of the healthy worker effect: The case of firefighting and heart disease, *Journal of Occupational and Environmental Medicine*, 42(10): 1021–1034.

Clark C and Zak MJ (1999). Fatalities to Law Enforcement Officers and Firefighters, 1992–97, *Compensation and Working Conditions*, Summer 1999, pp. 3–7.

Conrad KM, Balch GI, Reichelt PA, Muran S, and Oh K (1994). Musculoskeletal injuries in the fire service: Views from a focus group study, *American Association of Occupational Health Nurses Journal*, 42(12): 572–581.

Conrad KM, Reichelt PA, Lavender S, GackiSmith J, and Hattle S (2008). Designing ergonomic interventions for EMS workers: Concept generation of patient-handling devices, *Applied Ergonomics*, 39(6): 792–802.

Corneil W, Beaton R, Murphy S, Johnson C, and Pike K (1999). Exposure to traumatic incidents and prevalence of posttraumatic stress symptomatology in urban firefighters in two countries, *Journal of Occupational Health Psychology*, 4(2): 131–141.

Cullen KL, Williams RM, Shannon HS, Westmorland M, and Amick BC III (2005). Workplace organizational policies and practices in Ontario educational facilities, *Journal of Occupational Rehabilitation*, 15(3): 417–433.

Davis RL and Mostofi FK (1993). Cluster of testicular cancer in police officers exposed to hand-held radar, *American Journal of Industrial Medicine*, 24(2): 231–233.

Elliot DL and Kuehl KS (2007). *Effects of Sleep Deprivation on Fire Fighters and EMS Responders: Final Report*, Fairfax, VA: International Association of Fire Chiefs. As of October 30, 2008:
http://www.iafc.org/associations/4685/files/progsSleep_SleepDeprivationReport.pdf

Everyone Goes Home Firefighter Life Safety Initiatives (2008). Homepage. As of October 31, 2008:
<http://www.everyonegoeshome.com/>

Fahey RF, LeBlanc PR, and Molis JL (2006). *Firefighter Fatalities in the United States—2005*, Quincy, MA: National Fire Protection Association. As of October 30, 2008:
<http://www.nfpa.org/assets/files/PDF/osfff.pdf>

——— (2007). *What's Changed Over the Past 30 Years?* Quincy, MA: National Fire Protection Association. As of October 30, 2008:
<http://www.nfpa.org/assets/files/PDF/whatschanged.pdf>

——— (2008). *Firefighter Fatalities in the United States—2007*, Quincy, MA: National Fire Protection Association. As of October 30, 2008:
<http://www.nfpa.org/assets/files/PDF/osfff.pdf>

Federal Bureau of Investigation, Law Enforcement Officers Killed and Assaulted, 1994, FBI Uniform Crime Reports. As of November 4, 2008:
<http://www.fbi.gov/ucr/ucr.htm>

Feuerstein M, Berkowitz SM, and Huang GD (1999). Predictors of occupational low back disability: Implications for secondary prevention, *Journal of Occupational and Environmental Medicine*, 41(12): 1024–1031.

Finkelstein MM (1998). Cancer incidence among Ontario police officers, *American Journal of Industrial Medicine*, 34(2): 157–162.

Finkelstein EA, Chen H, Prabhu M, Trogdon JG, and Corso PS (2007). The relationship between obesity and injuries among U.S. Adults, *American Journal of Health Promotion*, 21(5): 460–468.

Franke WD, Ramey SL, and Shelley MC II (2002). Relationship between cardiovascular disease morbidity, risk factors, and stress in a law enforcement cohort, *Journal of Occupational and Environmental Medicine*, 44(12): 1182–1189.

Gillen M, Baltz D, Gassel M, Kirsch L, and Vaccaro D (2002). Perceived safety climate, job demands, and coworker support among union and nonunion injured construction workers, *Journal of Safety Research*, 33(1): 33–51.

Glazner JE, Borgerding J, Bondy J, Lowery JT, Lezotte DC, and Kreiss K (1999). Contractor safety practices and injury rates in construction of the Denver International Airport, *American Journal of Industrial Medicine*, 35, 175–185.

Golden AL, Markowitz SB, and Landrigan PJ (1995). The risk of cancer in firefighters, *State of the Art Reviews: Occupational Medicine*, 10(4): 803–820.

Grundy SM, Pasternak R, Greenland P, Smith S Jr, and Fuster V (1999). Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: A statement for healthcare professionals from the American Heart Association and the American College of Cardiology, *Circulation*, 100: 1481–1492.

Guidotti TL (1992). Human factors in firefighting—Ergonomic, cardiopulmonary, and psychogenic stress-related issues, *International Archives of Occupational and Environmental Health*, 64(1): 1–12.

Guidotti TL and Brandt-Rauf PW (1995). Occupational mortality among firefighters: Assessing the association, *Journal of Occupational and Environmental Medicine*, 37(12): 1348–1356.

Herbert R, Moline J, Skloot G, Metzger K, Baron S, Luft B, Markowitz S, Udasin I, Harrison D, Stein D, Todd A, Enright P, Stellman JM, Landrigan PJ, and Levin SM (2006). The World Trade Center disaster and the health of workers: Five-year assessment of a unique medical screening program, *Environmental Health Perspectives*, 114(12): 1853–1858.

Hessl SM (2001). Police and corrections, *State of the Art Reviews: Occupational Medicine*, 16(1): 39–49.

Hickman MJ and Reaves BA (2006). *Local Police Departments, 2003*, Washington, DC: U.S. Department of Justice, Bureau of Justice Statistics, Law Enforcement Management and Administrative Statistics, NCJ 210118. As of October 30, 2008: <http://www.ojp.usdoj.gov/bjs/abstract/lpd03.htm>

Hill J and Korber D (2004). CHP urges pension probe; Disability retirements may involve abuse or fraud, a report concludes, *Sacramento Bee*, December 1, 2004.

Horowitz MR and Montgomery DL (1993). Physiological profile of fire fighters compared to norms for the Canadian population, *Canadian Journal of Public Health/Revue Canadienne De Sante Publique*, 84(1): 50–52.

Houser AN, Jackson BJ, Bartis JT, and Peterson DJ (2004). *Emergency Responder Injuries and Fatalities: An Analysis of Surveillance Data*, Santa Monica, CA: RAND Corporation, TR-100-NIOSH. As of October 30, 2008: http://www.rand.org/pubs/technical_reports/TR100/

Huang YH, Ho M, Smith GS, Chen PY, and Mith S (2006). Safety climate and self-reported injury: Assessing the mediating role of employee safety control, *Accident Analysis and Prevention*, 38(3): 425–433.

International Association of Chiefs of Police (2003). Law Enforcement Stops and Safety, Web page. As of October 31, 2008:
http://www.theiacp.org/div_sec_com/committees/LESS/

International Association of Fire Chiefs (2008a). 2008 Fire/EMS Safety, Health, and Survival Week: Committed to Long-Term Results, June 22, 2008, Web page. As of October 31, 2008:
<http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=306>

——— (2008b). Fire Service Joint Labor Management Wellness-Fitness Task Force, Web page. As of October 31, 2008:
<http://www.iafc.org/displaycommon.cfm?an=1&subarticlenbr=382>

International Association of Fire Fighters (no date). Fire Service Joint Labor Management Wellness-Fitness Task Force, Web page. As of October 31, 2008:
<http://www.iaff.org/HS/Well/index.htm>

——— (2000). *2000 Death and Injury Survey*, Washington, DC: International Association of Firefighters, As of October 30, 2008:
<http://www.iaff.org/hs/PDF/2000%20D&I.pdf>

——— (2007). 2007 Fire and EMS Safety Stand Down, Web page. As of October 31, 2008:
<http://www.iaff.org/hs/Index1.asp>

Jankovic J, Jones W, Burkhart J, and Noonan G (1991). Environmental study of firefighters, *Annals of Occupational Hygiene*, 35(6): 581–602.

Kales SN, Freyman RL, Hill JM, Polyhronopoulos, GN, Aldrich JN, and Christiani DC (2001). Firefighters' hearing: A comparison with population databases from the International Standards Organization, *Journal of Occupational and Environmental Medicine*, 43(7): 650–656.

Kales SN, Soteriades ES, Christoudias SG, and Christiani DC (2003). Firefighters and on-duty deaths from coronary heart disease: A case control study, *Environmental Health: A Global Access Science Source*, 2: 14.

Kales SN, Soteriades ES, Christophi CA, and Christiani DC (2007). Emergency duties and deaths from heart disease among firefighters in the United States, *New England Journal of Medicine*, 356(12): 1207–1215.

Karter MJ (2006). *U.S. Fire Department Profile Through 2005*, Quincy, MA: National Fire Protection Association.

——— (2007). *Patterns of Firefighter Fireground Injuries*, Quincy, MA: National Fire Protection Association.

Karter MJ and Molis JL (2005). *U.S. Firefighter Injuries—2004*, Quincy, MA: National Fire Protection Association.

——— (2006). *U.S. Firefighter Injuries—2005*, Quincy, MA: National Fire Protection Association.

——— (2007). *U.S. Firefighter Injuries—2006*, Quincy, MA: National Fire Protection Association.

Kaufman KR, Brodine S, and Shaffer R (2000). Military training-related injuries—Surveillance, research, and prevention, *American Journal of Preventive Medicine*, 18(3): 54–63 Suppl. S Apr 2000.

Kessler RC, Barker PR, Colpe LJ, Epstein JF, Gfroerer JC, Hiripi E, Howes MJ, Normand S-LT, Manderscheid RW, Walters EE, Zaslavsky AM (2003). Screening for serious mental illness in the general population, *Archives of General Psychiatry*, 60(2), 184–189.

Kim P, Hayden JA, and Mior SA (2004). The cost-effectiveness of a back education program for firefighters: A case study, *Journal of the Canadian Chiropractic Association*, 48(1): 13–19.

Krueger AB (1990). Incentive effects of workers' compensation insurance, *Journal of Public Economics*, 41: 73–99.

Krueger K and Berner J (1995). *Review of Work Site Health and Fitness Programs*, Sacramento, CA: California Commission on Peace Officer Standards and Training, Clearing House Report No. 1.

Lahad A, Malter AD, Berg AO, and Deyo RA (1994). The effectiveness of 4 interventions for the prevention of low back pain, *Journal of the American Medical Association*, 272(16): 1286–1291.

Lakdawalla D, Reville RT, and Seabury SA (2007). How does health insurance affect workers' compensation filing? *Economic Inquiry*, 45(2).

LaTourrette T, Peterson DJ, Bartis JT, Jackson BA, and Houser A (2003). *Protecting Emergency Responders, Volume 2: Community Views of Safety and Health Risks and Personal Protection Needs*, Santa Monica, CA: RAND Corporation, MR-1646-NIOSH. As of October 30, 2008: http://www.rand.org/pubs/monograph_reports/MR1646/

Lope V, Pollán M, Gustavsson P, Plato N, Pérez-Gómez B, Aragonés N, Suárez B, Carrasco JM, Rodríguez S, Ramis R, Boldo E, and López-Abente G (2005). Occupation and thyroid cancer risk in Sweden, *Journal of Occupational and Environmental Medicine*, 47(9): 948–957.

Lucas R (1999). Violence in the pre-hospital setting, *Emergency Medicine Clinics of North America*, 17: 679–683.

- Ma F, Fleming LE, Lee DJ, Trapido E, and Gerace TA (2006). Cancer incidence in Florida professional firefighters, 1981 to 1999, *Journal of Occupational and Environmental Medicine*, 48(9): 883–888.
- Maguire BJ, Hunting KL, Smith GS, and Levick NR (2002). Occupational fatalities in emergency medical services: A hidden crisis, *Annals of Emergency Medicine*, 40(6): 625–632.
- Maguire BJ, Hunting KL, Smith GS, Guidotti TL, and Smith GS (2005). Occupational injuries among emergency medical services personnel, *Prehospital Emergency Care*, 9(4): 405–411.
- Mechem CC, Dickinson ET, Shofer ET, and Jaslow D (2002). Injuries from assaults on paramedics and firefighters in an urban emergency medical services system, *Prehospital Emergency Care*, 6(4): 396–401.
- Meyer BD, Viscusi WK, and Durbin DL (1995). Workers' compensation and injury duration: Evidence from a natural experiment, *American Economic Review*, 85(3): 322–340.
- Mledinger D, Chhajed PM, Stolz D, Gysin C, Wanzenried AB, Schindler C, Surber C, Bucher HC, Tamm M, and Leuppl JD (2007). Respiratory symptoms, atopy and bronchial hyperreactivity in professional firefighters, *European Respiratory Journal*, 30(3): 538–544.
- Nabeel I, Baker BA, McGrail MP Jr., and Flottemesch TJ (2007). Correlation between physical activity, fitness, and musculoskeletal injuries in police officers, *Minnesota Medicine*, 90(9): 40–43.
- National Center for Health Statistics (2006). *2005 National Health Interview Survey (NHIS) Public Use Data Release: NHIS Survey Description*, Washington, DC: Division of Health Interview Statistics, National Center for Health Statistics, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.
- (2007). International Classification of Diseases, Ninth Revision (ICD-9), Web page. As of November 4, 2008:
<http://www.cdc.gov/nchs/about/major/dvs/icd9des.htm>
- National Fire Fighter Near-Miss Protection System (no date). Homepage. As of October 31, 2008:
<http://www.firefighternearmiss.com/>
- National Fire Protection Association (2006). *Survey of Fire Departments for United States Fire Experience During 2005*, Quincy, MA: National Fire Protection Association.
- (2008). *Fire Department Calls and False Alarms*, Quincy, MA: National Fire Protection Association. As of October 30, 2008:
<http://www.nfpa.org/assets/files/PDF/OSFDCalls.pdf>

National Institute for Occupational Safety and Health (2007). *NIOSH Alert: Preventing Fire Fighter Fatalities Due to Heart Attacks and Other Sudden Cardiovascular Events*, Washington, DC: National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. As of October 31, 2008: <http://www.cdc.gov/niosh/docs/2007-133/pdfs/2007-133.pdf>

National Law Enforcement Officers Memorial Fund (2007a). "Causes of law enforcement deaths (1997–2006)," Web page. As of October 30, 2008: <http://www.nleomf.org/TheMemorial/Facts/causes.htm>

——— (2007b). Data supplied to authors, December 3, 2007.

National Volunteer Fire Council (no date). Heart-Healthy Firefighter, homepage. As of October 31, 2008: <http://www.healthy-firefighter.org/>

Oklahoma State University (2008). *Final Report for LODD Project: Phases I–II*, Oklahoma State University International Fire Service Training Association and Fire Protection Publications.

Østbye T, Dement JM, and Krause KM (2007) Obesity and workers' compensation, *Archives of Internal Medicine*, 167, 766–773.

Prezant DJ, Kelly KJ, Malley KS, Karwa ML, McLaughlin MT, Hirschhorn R, and Brown A (1999a). Impact of a modern firefighting protective uniform on the incidence and severity of burn injuries in New York City firefighters, *Journal of Occupational and Environmental Medicine*, 41(6): 469–479.

Prezant DJ, Dhala A, Goldstein A, Janus D, Ortiz F, Aldrich TK, and Kelly KJ (1999b). The incidence, prevalence, and severity of sarcoidosis in New York City firefighters, *Chest*, 116(5): 1183–1193.

Prezant DJ, Freeman K, Kelly KJ, Malley KS, Karwa ML, McLaughlin MT, Hirschhorn R, and Brown A (2000). Impact of a design modification in modern firefighting uniforms on burn prevention outcomes in New York City firefighters, *Journal of Occupational and Environmental Medicine*, 42(8): 827–834.

Prezant DJ, Barker RL, Stull JO, King SJ, Rotanz RA, Malley KS, Bender M, Guerth C, and Kelly KJ (2001). The impact of protective hoods and their water content on the prevention of head burns in New York City firefighters: Laboratory tests and field results, *Journal of Burn Care and Rehabilitation*, 22(2): 165–178.

Prezant DJ, Weiden M, Banauch GI, McGuinness G, et al. (2002). Cough and bronchial responsiveness in firefighters at the World Trade Center site, *New England Journal of Medicine*, 347(1): 806–815.

Rabbitts A, Alden NE, Scalabrino M, and Yurt RW (2005). Outpatient firefighter burn injuries: A 3-year review, *Journal of Burn Care and Rehabilitation*, 26(4): 348–351.

Reinhardt TE and Ottmar RD (2004). Baseline measurements of smoke exposure among wildland firefighters, *Journal of Occupational and Environmental Hygiene*, 1(9): 593–606.

Reville RT, Polich S, Seabury SA, and Giddens E (2001). *Permanent Disability at Private, Self-Insured Firms: A Study of Earnings, Loss, Replacement and Return to Work for Workers' Compensation Claimants*, Santa Monica, CA: RAND Corporation, MR-1268-ICJ. As of November 4, 2008:
http://www.rand.org/pubs/monograph_reports/MR1268/

Reville RT and Seabury SA (2000). The compensation of workplace injuries and illnesses for public safety employees: A comparison of California Labor Code 4850 to a sample of federal, state and municipal programs in the United States, unpublished.

Reville RT, Seabury SA, and Neuhauser F (2004). *Evaluation of California's Permanent Disability Rating Schedule: Interim Report*, Santa Monica, CA: RAND Corporation, DB-443-ICJ. As of October 30, 2008:
http://www.rand.org/pubs/documented_briefings/DB443/

Reville RT, Seabury SA, Neuhauser F, Burton JF Jr., and Greenberg MD (2005). *An Evaluation of California's Permanent Disability Rating System*, Santa Monica, CA: RAND Corporation, MG-258-ICJ. As of November 4, 2008:
<http://www.rand.org/pubs/monographs/MG258/>

Robinson WV, and Nankin J (2008). Firemen getting enhanced pensions, *Boston Globe*, January 7, 2008.

Sengupta I, Reno V, and Burton JF Jr. (2008). *Workers' Compensation: Benefits, Coverage and Costs, 2006*, Washington, DC: National Academy of Social Insurance.

Shephard RJ (1996). Worksite fitness and exercise programs: A review of methodology and health impact, *American Journal of Health Promotion*, 10(6): 436–452.

Smeets RJEM, Wittink H, Hidding A, and Knottnerus JA (2006). Do patients with chronic low back pain have a lower level of aerobic fitness than healthy controls? *Spine*, 31(1): 90–97.

Stagnero V (2006). Firefighter fatalities: The preventable losses, *Fire Engineering*, 159(6).

Studnek JR and Crawford JM (2007). Factors associated with back problems among emergency medical technicians, *American Journal of Industrial Medicine*, 50(6): 464–469.

Tubbs, RL (1995). Noise and hearing loss in firefighting, *State of the Art Reviews: Occupational Medicine*, 10(4): 843–856.

U.S. Census Bureau (2008). Current Population Survey, homepage. As of October 31, 2008:

<http://www.census.gov/cps/>

U.S. Department of Labor, Bureau of Labor Statistics (2007). Current Population Survey. As of October 30, 2008:

<http://www.bls.gov/cps/cpsaat11.pdf>

——— (2008a). National Census of Fatal Occupational Injuries. As of October 31, 2008:

<http://www.bls.gov/iif/oshcfoi1.htm>

——— (2008b). Injuries, Illnesses, and Fatalities, Web page. As of October 31, 2008:

<http://www.bls.gov/iif/>

U.S. Department of Justice, Bureau of Justice Statistics (2007). Law Enforcement Statistics. Online at <http://www.ojp.usdoj.gov/bjs/lawenf.htm>

U.S. Fire Administration (1997). *Fire in the United States, 1985–1994*. Washington, DC: Federal Emergency Management Agency.

——— (1999). *Fire in the United States: 1985–1994*, Washington, DC: Federal Emergency Management Agency. As of October 30, 2008:

<http://www.usfa.dhs.gov/downloads/pdf/publications/fius9th.pdf>

——— (2002). *Firefighter Fatality Retrospective Study*, Washington, DC: Federal Emergency Management Agency, USFA FA-220. As of October 30, 2008:

<http://www.usfa.dhs.gov/downloads/pdf/publications/fa-220.pdf>

——— (2004a). *Emergency Vehicle Safety Initiative*, Washington, DC: U.S. Department of Homeland Security, USFA FA-272. As of October 30, 2008:

<http://www.usfa.dhs.gov/downloads/pdf/publications/fa-272.pdf>

——— (2004b). *Fire in the United States: 1992–2001*, Washington, DC: U.S. Department of Homeland Security, USFA FA-286. As of October 30, 2008:

<http://www.usfa.dhs.gov/downloads/pdf/publications/fa-286.pdf>

——— (2007a). Emergency Vehicle Safety, Web page. As of October 31, 2008:

<http://www.usfa.dhs.gov/fireservice/research/safety/vehicle.shtm>

——— (2007b). *Fire in the United States: 1995–2004*, Washington, DC: U.S. Department of Homeland Security, DC, FA-311. As of October 30, 2008:

<http://www.usfa.dhs.gov/downloads/pdf/publications/fa-311.pdf>

——— (2007c). *Firefighter Fatalities in the United States in 2006*, Washington, DC: U.S. Department of Homeland Security. As of October 30, 2008:

http://www.usfa.dhs.gov/downloads/pdf/publications/ff_fat06.pdf

——— (2008a). Firefighter casualties 1998–2007, Web page. As of October 30, 2008:

<http://www.usfa.dhs.gov/fireservice/fatalities/statistics/casualties.shtm>

——— (2008b). Firefighter Fatality Database, Web site. As of October 30, 2008: http://www.usfa.dhs.gov/applications/ffmem/tally_report.jsp

——— (2008c). *Firefighter Fatalities in the United States in 2007*, U.S. Department of Homeland Security, Washington, DC. As of October 30, 2008: http://www.usfa.dhs.gov/downloads/pdf/publications/ff_fat07.pdf

Violanti JM, Vena JE, and Petralia S (1998). Mortality of a police cohort: 1950–1990, *American Journal of Industrial Medicine*, 33: 366–373.

Walton SM, Conrad KM, Furner SE, and Samo DG (2003). Cause, type, and workers' compensation costs of injury to fire fighters, *American Journal of Industrial Medicine*, 43: 454–458.

Waters JA and Ussery W (2007). Police stress: History, contributing factors, symptoms, and interventions, *Policing: An International Journal of Police Strategies and Management*, 30(2): 169–188.

Womack JW, Green JS, and Crouse SF (2000). Cardiovascular risk markers in firefighters: A longitudinal study, *Cardiovascular Reviews and Reports*, 21: 544–548.

Xiang H, Smith GA, Wilkins JR III, Chen G, Hostetler SG, and Stallones L (2005). Obesity and risk of nonfatal unintentional injuries, *American Journal of Preventive Medicine*, 29(1): 42–45.