

# INJURIES, ILLNESSES, AND FATALITIES AMONG WILDLAND FIREFIGHTERS\*



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Wildland firefighting activities take place in a high-risk environment. The firefighters involved in these activities are often at risk, both in the short term and the long term, of illnesses, injuries, and sometimes even death. In the United States, 133 individuals died in activities associated with wildland fire suppression from 1990 to 1998. Australia has also experienced numerous fire-related fatalities during the same period, and other firefighters around the world have died in Greece, Mongolia, Russia, and South Africa.

This article discusses factors that are critical to both firefighters and fire managers in ensuring a safe and productive workforce. First, it discusses such items as the work environment, the firefighter workforce, physical fitness, nutrition, work/rest cycles, lifestyle choices, and job requirements. Next, it reviews firefighter illnesses, injuries, and fatalities, with the purpose of identifying mitigation measures for reducing and/or eliminating the risks from the fire environment. The mitigation measures suggested are applicable to firefighters at all organizational

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levels: Federal, State, rural, volunteer, and contractor.

## Work Environment

A wide variety of environmental conditions exist in the world of wildland fire suppression: From the Arctic tundra to the Florida everglades; from the eucalypt forest of Australia to the chaparral of southern California; and from the ponderosa pine forests of Montana to the pine barrens of New York and New Jersey, the extent of ecosystems that experience fires is truly worldwide.

Numerous factors compound the already stressful work of suppressing fires: elevations that range from sea level to more than 6,500 feet (2,000 m); steep, uneven ground; high ambient air temperatures that often exceed 95 °F (35 °C); and above-average levels of smoke and dust. All these conditions have the potential to affect the on-the-ground performance of the wildland firefighter; they can ultimately result in illness, injury, or even death. These factors, especially for individuals not acclimated to them, can have a cumulative effect on a firefighter's ability to resist these exposures and risks.

## Firefighter Workforce

The individuals who participate in wildland firefighting operations are as varied as the fuel and terrain types that they fight fire in: females and males of all racial backgrounds, at least 18 years old but often into their 60s and 70s. They might weigh less than 100 pounds (45 kg) or more than 250 pounds (113 kg) and range from less than 5 feet (1.5 m) tall to more than 6.5 feet (2.0 m) tall.

Firefighters are truly a cross-section of the population that they serve. Although some fire agencies have physical fitness requirements, firefighters often come to the fire environment with the same physical conditions as the general population: allergies to smoke and dust; trick knees; weight and fitness problems; and other preexisting conditions that might surface on the fireline.

## Firefighting Job

Besides environmental and human factors, another critical factor that contributes to the illnesses, injuries, and deaths suffered by wildland firefighters is the actual job itself. Long hours of arduous work under difficult physical conditions,



*Environmental smoke is a constant health hazard for wildland firefighters, whether on wildfires or prescribed burns (as here, on Nevada's Toiyabe National Forest). Photo: USDA Forest Service, 1994.*

coupled with reduced sleep and dietary changes, plus working closely with a new group of individuals in a less-than-hygienic setting, with the potential for exposure to previously unseen infections during a period of reduced immunity: All these are prime conditions for illness and/or injury to the firefighter, especially on multiday fire assignments.

Fighting wildland fires has unique physical fitness requirements, unlike most other jobs in the civilian workforce. Both lower and upper body strength are needed to complete the necessary tasks, and endurance is essential to work for the extended periods of time required to control the unwanted fires. In addition, there is always the unexpected action of responding to a flareup on the control line, or, even worse, the need to make a rapid retreat when a fire threatens the firefighter's personal safety, especially after long hours on the line. Studies at the University of

Montana's Human Performance Laboratory in Missoula, MT, have shown that aerobic fitness is the primary limiting factor in the firefighter's ability to sustain hard work throughout the long workshifts.

Like athletes, serious firefighters realize that physical activity and training are a year-round requirement if they are to successfully meet the demands of the job. This requirement is often difficult to meet, especially in a workforce that has many other demands on its available time.

### Individual Factors

A number of factors affect the ability of an individual to perform wildland fire suppression activities in a safe and efficient manner (Davis 1999). Some are beyond the individual's ability to influence, but many are well within the individual's total control. Factors that are inherited (such as physical height and weight) and those that are

controlled by the environment (such as heat, humidity, and elevation) are interesting to contemplate, but are beyond the scope of our ability to affect in the context of wildland firefighting.

There are, however, a number of items that individual firefighters, whether volunteer or full-timer, can affect through their own actions and attitudes. Although physical height is a genetically inherited factor, an individual has a range of options regarding lean body weight, physical fitness level, and muscular endurance. These factors are a direct result of the firefighter's choices regarding nutrition and exercise regimes—that is, the firefighter's motivation to prepare for the job at hand.

Whereas these factors are generally considered long term, other factors tend to be affected more by short-term actions. For example, acclimatization with respect to both heat and elevation can be changed within a relatively short time. As temperatures rise during the early stages of a fire season, firefighters should begin moderate levels of outside activity to prepare themselves for the inevitable fires that will require extended physical activity. Similarly, higher levels of hydration and nutrient supplements will be necessary during prolonged periods of strenuous activity during periods of high heat loads, both from the ambient air and from the fires.

### Firefighter Illnesses

**Infectious Disease.** The illnesses that firefighters are subject to are not that different from those suffered by other large groups of individuals thrown together in a close environment—such as sailors at sea, or teachers and students in a

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Long hours of arduous work under difficult physical conditions, coupled with reduced sleep and dietary changes, expose firefighters to increased risk of illness and injuries.

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classroom—for extended periods of time. Infection and disease in any one individual can cause illness in other individuals who have not had previous exposure and the opportunity to develop an immune response. In addition to bringing a large group of individuals together, wildland fires also complicate matters by requiring long hours of hard work, coupled with a change in diet and sleep patterns. These factors, in addition to the exposure to smoke and dust, result in a variety of illnesses among firefighters, especially as the duration of a fire assignment progresses beyond the first week.

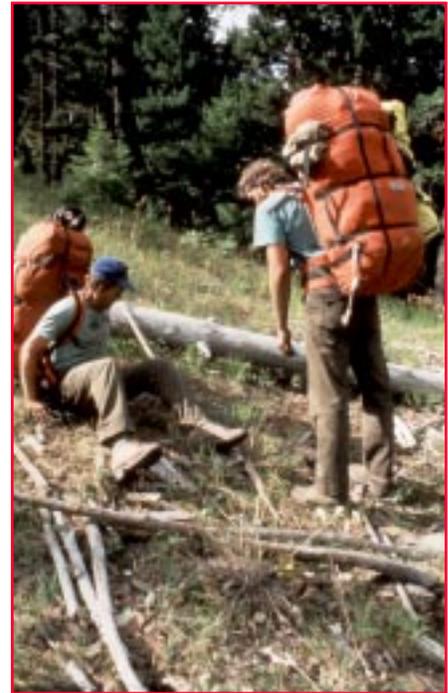
**Environmental Smoke.** The short-term and long-term exposure to high levels of environmental smoke from wildland fires was most apparent during the 1987 and 1988 fire seasons. In those years, smoke inversions plagued not only the immediate fire area, but also the incident base camps and surrounding communities for days on end. For firefighters spending multiple 21-day assignments under these conditions, the incidence of upper-respiratory-tract infections was high; infections lasted for periods as long as 3 to 4 months after the firefighting operations were over. As a result, the Health Hazards of Smoke project sponsored by the National Wildfire Coordinating Group was undertaken at the Missoula Technology and Development Center (MTDC). The 6-year project culminated in 1997 with a conference in Missoula, MT, that summarized the research findings

and developed mitigation measures for on-the-ground fire operations to reduce exposure to smoke (Sharkey 1997a).

The long fire season in northern Idaho and western Montana in 1994 offered another opportunity to look at the incidence of illness among firefighters on large incidents managed by fire overhead teams. An informal review of medical records conducted by Mark Vore from the Idaho Panhandle National Forests showed that nearly 40 percent of the visits to the incident medical units were documented as respiratory problems. These findings are consistent with the problems that surfaced in 1987–88 and could surface again, given the mountainous terrain and inversion potential on many large wildfires and prescribed burns in the Western United States.

**Heat Stress.** Another illness issue that appears to be on an upward trend on wildland firefighting operations is the incidence of heat stress injuries. Under conditions of both high ambient air temperatures and high radiant heat flux, the firefighter can easily become dehydrated and subject to heat stress if positive preventative measures are not implemented as a normal way of doing business on a daily basis.

An Australian study (Budd and others 1996) on work productivity among bush firefighters indicated that personal protective clothing was a key factor in reducing heat



*Smokejumpers in training. Like athletes, serious firefighters realize that physical activity and training are a year-round requirement if they are to successfully meet the demands of the job. Photo: Paul S. Fieldhouse, USDA Forest Service, Missoula Smokejumper Base, Missoula, MT.*

stress. Project “Aquarius” noted that two-thirds of the firefighter’s heat load was generated internally, with only one-third coming from the radiant heat of the fire. The study recommended that the design of protective clothing should be to “let heat out, not keep heat out.” Additionally, it recommended that wildland firefighters consider the need to consume as much as 1 liter (2 pints) of fluids per hour under high temperatures and heavy workload conditions.

The logistics of supporting this level of fluid replacement during a 12-hour operational period can be challenging, but it is certainly essential to prevent heat stress illness. Dehydration and heat stress illness can be the result of a progressive deterioration that occurs over several days of reduced fluid intake. They can also be com-

pounded by other factors, such as other illnesses or medications being taken by the individual.

**Countermeasures.** Fire managers and crew leaders should take positive actions to avoid working firefighters to the point of exhaustion or exposing them to excessive levels of smoke. Additional actions that can help reduce firefighter illness include:

- Reducing both physical and emotional stress;
- Enhancing rest and recuperation periods, with a target of a 2-to-1 work/rest cycle (16 hours of work, followed by 8 hours of rest); and
- Providing adequate energy and nutrients to meet the special requirements of the arduous fire job.

Firefighters have an individual responsibility to ensure their own ability to perform the job by getting and staying in good physical condition; making correct nutritional choices to sustain them on multihour and multiday fire assignments; and making healthy lifestyle choices (such as not smoking), which will help them remain on the job during periods of reduced immunity to illnesses.

Dr. Steve Wood from Abbott Laboratories has identified “immune-friendly nutrients” that enhance the function of the human immune system (Wood 1999). They include vitamins C and E, which both stimulate and enhance immune response; Beta carotene, which stimulates natural killer cells; vitamin B6, which promotes white-cell proliferation; selenium, which promotes antibacterial activity; and zinc, which promotes wound healing. All these nutrients can be helpful in reducing the risk of

firefighter illness in the bushfire environment.

## Firefighter Injuries

In difficult terrain, under conditions of long hours and arduous work, injuries are one of the major perils that wildland firefighters are subject to. Although no documented records exist showing trends of firefighter injuries, on-the-ground observations by experienced personnel show several major areas where injuries occur:

- Vehicle accidents;
- Tool use;
- Slips, trips, and falls; and
- Muscle strains.

By inference, several of these injury areas can be related back to the causal factors of fitness levels and fatigue.

**Fatigue.** As firefighters become more fatigued from the long hours and arduous work, they become less attentive to the small things that prevent injuries under different circumstances: using care in walking on steep slopes, over logs,

and down cut slopes; clearing obstacles and using full muscle control when swinging handtools; using proper lifting techniques for heavy objects; and paying full attention to driving techniques on winding, steep, and/or unsurfaced roads.

Although accidents are not well enough documented to show their rate of occurrence during firefighting operations, experienced personnel are well aware of the risks. Better documentation will more clearly define the problems and lead to mitigation practices that will ultimately reduce the risk. The MTDC publication *Fitness and Work Capacity* (Sharkey 1997b) documents many of the conditioning techniques that can reduce firefighter fatigue by increasing work stamina.

**Fitness Levels.** A number of recent studies have documented the relationship between fitness levels and injury rates. In the U.S. Army, a study of 861 female and male trainees indicated that the fittest soldiers (measured by their



*Firefighters relaxing. Firefighters should manage work/rest cycles to avoid needless fatigue. Photo: USDA Forest Service.*

pushups, situps, and 2-mile [3.2-km] runs) experienced the lowest injury rates. Another study showed that the most fit individuals, as indicated by running speed, experienced the fewest injuries in sports training. Finally, a 1999 Australian Army study of recruits indicated a negative relationship between fitness and injuries. The implications of these studies for firefighters are obvious, especially for such a physically demanding activity.

## Firefighter Fatalities

The first half of the 1990s saw two major wildfire fatality events that riveted the attention of the Nation: the Dude Fire in 1990 killed 6 firefighters, and 14 firefighters died on the South Canyon Fire in 1994. Although these tragic events were horrific reminders of the risks inherent in wildland fire suppression activities, they were only a few of the deaths that occurred from 1990 to 1998. In that period, 133 firefighters and others involved in wildland firefighting operations died from a variety of causes. The MTDC report *Wildland Fire Fatalities in the United States: 1990 to 1998* (Mangan 1999) documents the causes, including aircraft accidents (30 deaths), heart attacks (28 fatalities), and vehicle accidents (25 deaths).

Numerous opportunities exist to reduce firefighter fatalities away from the immediate fire ground through many of the same actions that will reduce illness and injuries. Prevention of heart attacks offers the best opportunity to reduce the number of deaths. However, preventing heart attacks will require a major lifestyle change for many firefighters.

In the progression of events, it can be surmised that fatalities on wildland firefighting operations are, in many cases, the logical extension of early failures to address issues of illness and injuries that manifest themselves throughout the fire season. It is imperative that we break the chain if we are to ultimately reduce firefighter fatalities.

## Toward Safety and Health

The safety and health of the wildland firefighting workforce is critically important to the firefighters and their families, the fire management organization, and the community it serves. There are numerous opportunities, both short-term and long-term, to improve the health and safety of the wildland workforce for all firefighters:

- First and foremost, individual firefighters must take positive and affirmative actions to ensure their own health and safety. This includes maintaining an appropriate height/weight ratio, participating in an exercise program, and minimizing high-risk activities that threaten good health.
- Fire agencies have a major obligation to provide an environment that fosters a safe and healthy workforce. This can include health-screening programs; exercise facilities; and, in some cases, work capacity testing.
- Fire agencies should provide specialized training in high-risk activities, such as emergency vehicle operation; and create a culture that does not condone or tolerate unsafe work practices, even during a fire emergency.

- During multiday firefighting operations, fire managers and crew leaders should ensure that fluid and nutritional needs are met and that work/rest cycles are managed to prevent unnecessary fatigue among both firefighters and fire managers.
- Fire agencies should develop, maintain, and monitor an illness and injury data base, preferably at the national level, to identify health and safety trends in the wildland fire community.

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