Wildland Firefighter Health & Safety Report

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The National Wildfire Coordinating Group (NWCG) coordinates firefighting efforts among Federal and State agencies. As part of the NWCG's mandate to ensure current, shared information, a report on Wildland Firefighter Health and Safety issues will be published twice each year by the Missoula Technology & Development Center (MTDC). It will include activities related to the MTDC project on firefighter health and safety, including summaries of research, abstracts of related reports, articles, and field notes. Practical approaches to manage fatigue, environmental stress, and other factors that compromise the health and safety of wildland firefighters will be reported, and upcoming events will be announced.

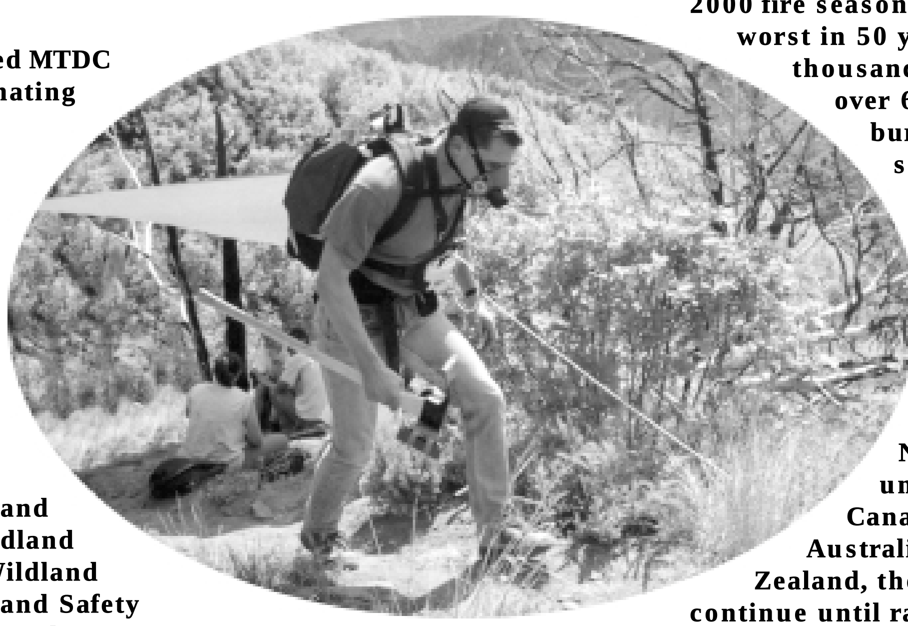
Background

The NWCG assigned MTDC the task of coordinating the Wildland Firefighter Health and Safety project and serving as the focal point for ongoing and future studies. MTDC has conducted many research and development projects related to the health, safety, and productivity of wildland firefighters. The Wildland Firefighter Health and Safety project will focus on three main areas and goals:

Work/Rest Issues—**Development of an objective approach for the determination of work/rest standards, and recommended assignment lengths for crews and overhead.**

Energy and Nutrition—**Improvement of the energy intake, nutrition, and immune function of wildland firefighters.**

Fitness and Work Capacity—**Implementation of medical screening and work capacity standards, and improvements in the health, safety and productivity of firefighters.**



Subject departs field lab on Storm King Mountain during a simulated escape route evacuation (see page 6).

Fires of 2000

As this report goes to press, the 2000 fire season ranks as the worst in 50 years. With thousands of fires and over 6 million acres burned, the season has strained human and physical resources. While help has come from Army, Marine, and National Guard units, and from Canada, Mexico, Australia, and New Zealand, the fires may continue until rain or snow aids suppression efforts.

0051-2855-MTDC

Wildland Firefighting and the Immune Response

Steve Wood, Ph.D., R.D.

Wildland firefighters perform their jobs in a number of conditions that may suppress the immune system and increase the risk of illness. This paper examines the influences of physical and psychological stresses on immune function and presents a military model, containing many of the stresses found in wildland firefighting, of a field nutrition study where immune suppression was minimized.

The Immune System—**The immune system is an intricate system of organs, tissues, cells, and molecules that maintain balance between the environment and the body. Stresses such as physical exertion, sleep deprivation, malnutrition, extreme temperatures, smoke, psychological pressures, and endocrine changes influence the body's defense system and alter its equilibrium. The environment we live in has a variety of infectious microbes (viruses, bacteria, fungi, parasites, and protozoa). If these multiply unchecked, they can cause sickness, disease, and death. Our bodies combat these microorganisms through immune responses. The skin is the first line of defense. While few infectious agents can penetrate intact skin, they may gain access across epithelial tissues, or through the gastrointestinal or urogenital tracts. Once an organism has gained access, the immune system must recognize the pathogen or foreign material and mount an attack (immune response).**

Immune responses are coordinated primarily by white blood cells (leukocytes). Once the white blood cells identify the foreign material, the immune system mounts an attack to bind and destroy it (phagocytosis). The immune response is much like an orchestra. When cells and organs are working together, the immune system functions effectively; however, if cells and organs are not working harmoniously, the risk of disease and illness increases.

Energy and sleep deprivation, mental stress, and intense physical exertion affect the immune system. It is possible to measure overall immune system effectiveness by using clinical measures such as delayed-type hypersensitivity (DTH), the rate of infection or response to pathogen or vaccine. DTH tests can be administered easily by placing small amounts of proteins that cause a reaction (antigens) into the epidermis and superficial dermal tissue (Table 1).

Persons who are DTH reactive have a much lower rate of infection than those who are anergic (not responsive). If persons who are anergic become infected, they have a poor prognosis. A reduction in cell-mediated immune responses can limit the development of an effective immune response against intracellular pathogens, including viruses, bacteria, fungi, and protozoa. DTH has also been used to evaluate the immune function of patients who are malnourished, whose immune system is suppressed, or who have experienced trauma.

Firefighting Stress—**Wildland firefighters are exposed to many stresses that can affect their health and influence their immune systems. In addition to the psychological challenges of firefighting, a number of physical challenges (such as environmental toxins, injuries, smoke inhalation, and burns) could cause the immune system to be suppressed. Although many studies have evaluated the effectiveness of equipment for wildland firefighters, none has focused directly on the health of the firefighter's immune system. Therefore, we will examine research conducted in similar situations to evaluate factors**

Table 1: Delayed-Type Hypersensitivity (DTH), infection, and death rate.

	Infection Rate (percent)	Death Rate of infected patients (percent)
Reactive	7	19
Relative Anergy*	16	32
Anergy	25	51

*Anergy, the lack of response, indicates impairment of the immune system.
Based on skin testing of 4,289 hospitalized patients (Christou and others, 1995).

that may influence the wildland firefighter's immune system.

Stress and Infection—**What happens to the immune system as a result of stress? Do changes in the immune system translate into increased susceptibility to disease? In 1991 Peterson and others reviewed stress and the pathogenesis of infectious disease. The authors reviewed many studies in which stressors (exertion, electric shock, isolation or crowding, and exposure to cold temperatures) were imposed on animals.**

Several epidemiological studies have documented an increased incidence of upper respiratory tract infection after strenuous exercise. On the other hand, individuals who exercise moderately have a lower risk of infection than those who are sedentary. Regular moderate exercise appears to convey enhanced immunological responses. More chronic and severe stress, such as that experienced by persons training in the U.S. Army Special Forces Assessment and Selection School (SFAS), decreases immune function and increases susceptibility to environmental pathogens (Figure 1).

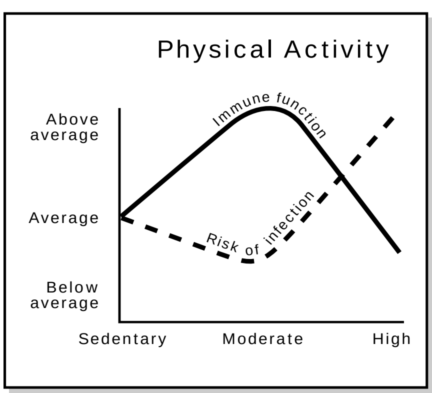


Figure 1—The relationship of physical activity to immune function and risk of infection.

Ambient conditions also can influence immune function and susceptibility to infection. Animals maintained at low temperatures experience higher rates of infection. Animal studies found females more resistant to the effects of crowding. Lack of sleep has been shown to reduce immune function. Rats that are deprived of sleep drastically increase their food consumption (hyperphagia) but they lose weight (malnutrition-like symptoms) and may succumb to lethal systemic infections.

Readiness and Impact on Time Lost—**The effect of decreased immune function on firefighter readiness and lost work hours has not been reported. However, corollaries from military studies can be used to establish the effects. For example, in several major U.S. military conflicts disease and nonbattle injuries (DNBI) have accounted for significant loss of manpower.**

Exposure to pathogens from environmental factors and crowded living quarters contribute to disease susceptibility in military units even during routine peacetime operations. Seay and others found that 777 cases of gastroenteritis were reported after a 10-day port visit. The illness affected 15 percent of the work force and cost 462 days of lost work. Seay stated, "Lost duty days, and the burden of providing medical confinement may be more critical than fatal illnesses. Fatalities may be replaced but sick soldiers continue to occupy positions, decrement performance, and consume large quantities of medical supplies." While many factors may contribute to susceptibility to infection and disease during military operations, the effect of physical and psychological stress undoubtedly have a significant impact.

Physical and Nonphysical Stresses—**Stressors, such as exertion and extreme environmental temperatures, can affect the immune system. The changes are similar to nonphysical stresses (such as isolation). In human studies, nonphysical and physical stress can produce immunological changes.**

Chemicals in the smoke wildland firefighters may be exposed to can affect the immune system. Smoke exposure has been a recognized health issue for many years. A few studies of firefighters in the 1970's hinted that smoke exposure contributed to fatigue and injury. The main inhalation hazards are carbon monoxide, aldehydes, benzene, acrolein, and particulate matter small enough to reach the lungs.

Nutrition—**Starvation has been shown to affect the immune system. Nutritional deficiencies or suboptimal nutrient levels can be the result of eating too little food, decreased absorption of nutrients, or increased use of nutrients. Many nutrients are required for optimal functioning of the immune system. The effect of infection on nutritional status is characterized by wasting of peripheral tissues, particularly lean body mass (muscle). Nutrients (vitamins and minerals) are used as substrate and cofactors for immune cells. Once an infection takes place, immune cells have a higher requirement for nutrients. After infection, particularly of** the gastrointestinal tract, the gut's mucosal lining may be damaged and the microflora of the gut may change, decreasing the small intestine's absorptive capacity. The mucosal and microflora changes can also be influenced by antibiotics and medications, further decreasing the effectiveness of nutrient absorption. An infection may also increase use of nutrients. Nutrient supplementation can prevent malnutrition and provide the essential factors for immune cells to function optimally.

The era of nutritional manipulation of the immune system has finally dawned and it brings with it the promise of using diet and nutrition as innovative powerful tools to reduce illness and death caused by infection.
R.K. Chandra, Proceedings of the National Academy of Science.

Nutrient supplementation can improve immune function, counteracting the stress-induced immune changes. Supplementation to minimize or prevent immune changes and protect individuals who are undergoing physical stress has been studied to a limited extent. Nutrients such as vitamin C may play a role in immune function and may prevent immune suppression in physically stressed individuals. Peters and others supplemented the diets of runners with 600 mg vitamin C per day or a placebo for 21 days before an ultramarathon. Sixty-eight percent of the runners who consumed the placebo reported upper respiratory tract infections compared with 33 percent of those who consumed the vitamin C.

Giuliani and Cesaro report that physical activity raises oxygen demand severalfold, increasing the formation of oxygen radical species or free radicals. As oxygen radical species are formed, they adversely affect immune function. Theoretically, providing antioxidants in sufficient amounts during exercise-induced oxidative stress may maintain the immune system. Several reviews have been published on the importance of dietary antioxidants and their influence on the immune response.

Army Special Forces and Ranger Training—**Ross Products Division of Abbott Laboratories has investigated potential benefits of nutrient supplementation and nutritional strategies to minimize immunologic changes in a variety of conditions. The military stresses (carrying heavy packs and equipment, strenuous physical exertion, exposure to extreme temperatures, and psychological stress) seem to be similar to those experienced by wildland firefighters.**

Historically, military deployment has been associated with an increased incidence of infectious diseases. Furthermore, soldiers in military training have incurred more outbreaks of infectious disease than would be expected, pointing toward an underlying susceptibility. The United States Army Special Forces Assessment and Selection Course (SFAS) is highly demanding, physically and emotionally. Fairbrother and others documented a negative energy balance (1,379 kcals/day) in soldiers who participated in the 21-day course; however, no significant clinical manifestations of vitamin or mineral deficiencies were noted. One observation from that study was a reduced lymphocyte proliferation response. This observation suggested that multiple stressors (negative energy balance, sleep deprivation, physical activity, and psychological stress) may have negative effects on immune function and the ability of lymphocytes to combat infections. Bernton and others found that during Ranger training DTH skin anergy increased over time. Those trainees who did respond had a decreased response.

Nutritional intervention with this group allowed for an evaluation of nutritional supplementation on immune function. Two hundred soldiers participating in an SFAS course volunteered to participate in this prospective, randomized, blinded, placebo-controlled study. The test group (n = 100 soldiers) consumed their regular diet consisting mainly of meals ready-to-eat (MRE) plus a novel ready-to-eat treatment product (8 oz two times per day) containing antioxidants, minerals, a structured lipid (from long- and medium-chain fatty acids), and indigestible carbohydrates. The control group (n = 100 soldiers) was given a ready-to-eat product similar to the treatment product in taste and appearance with a similar amount of energy but without antioxidants, minerals, and the structured lipid. Dietary intake, body weight, and immune function were measured before and after the physically and psychologically demanding 21-day training course.

Fifty percent of the soldiers in the treatment group completed the SFAS course compared to 57 percent in the control group. Subjects lost about 6.4 pounds in 3 weeks. Combining the dietary intake with the weight loss data, soldiers had an estimated energy expenditure of 5,040 kcals per day. The DTH test after training suggested that subjects consuming the treatment product had a greater response ($P = 0.07$). Fewer subjects in the treatment group were DTH anergic (18 percent) to the skin test compared to the control group (39 percent), suggesting a lower risk for infections in the treatment group. Overall, the treatment formula appeared to minimize the immunologic changes associated with the stresses of SFAS training.

A similar 62-day study was conducted during Ranger training, in which trainees received a nutrition bar with a nutrient profile similar to the ready-to-drink formula used in the SFAS study. The treatment bar lessened some of the immunological changes and appeared to help maintain weight better than the placebo product.

Conclusions

The immune system is an intricate and highly regulated network of cells, tissues and molecules that help ward off infections and disease. Although the effectiveness of the immune response can be influenced by a number of stressors, specialized nutrition can help maintain the immune system.

No studies have been conducted to evaluate immune function in wildland firefighters; however it is likely that they experience some level of immune suppression from the physical and emotional stresses. If there is an increased rate of infection, it would be valuable to study strategies (such as nutritional supplementation) that might influence the immune systems under these conditions. Nutritional formulations tested in military training, where the physical and psychological stress may be similar to wildland firefighting, may also be of value.

Steven Wood, Ph.D., RD, is senior clinical project leader associated with Ross Products Division, Abbott Laboratories. The complete text of this paper may be found in *Wildland Firefighter Health and Safety: Recommendations of the April 1999 Conference*, 9951-2841-MTDC. The paper contains references and a list of nutrients and their influence on immune function.

Firefighter Immunity

Mark Vore of the Idaho Panhandle National Forests analyzed 1994 Northern Rockies fire camp medical records. He found that 30 to 50 percent of the visits to medical tents were for upper respiratory problems, including coughs, colds, and sore throats. Similar results were noted by a team investigating fatigue and stress during the 2000 fire season. A number of factors in the firefighting environment influence immune function and the body's susceptibility to respiratory and other illnesses. Upper respiratory problems can be due to fatigue, stress, smoke exposure, inadequate nutrition, or a combination of stresses. Rapid weight loss and sleep deprivation have also been associated with decreased immune function.

Fire managers and crew leaders should do all they can to avoid exhausting firefighters and exposing them to excess smoke. Managers can reduce stress by providing up-to-date information, by soliciting input from crew members, and by minimizing crowding, waiting, and other factors that contribute to stress . They can enhance rest and recuperation by providing adequate time and conditions for sleep. And they can ensure firefighter fitness with early-season conditioning and heat acclimatization. Firefighters are responsible for preseason conditioning and nutritional food choices. Fire camp meals provide adequate energy and nutrients. Firefighters must consume adequate calories to maintain energy, and eat adequate servings of fruits and vegetables or consider multi-vitamin/mineral supplements.

Research

Wildland Firefighter Load Carriage: Effects on Transit Time and Physiological Responses During Simulated Escape Route Evacuation.

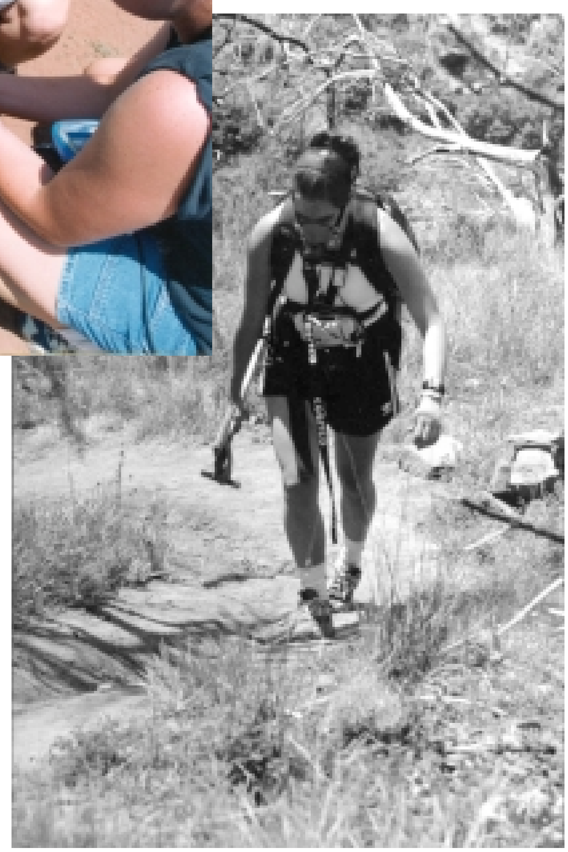
B. Ruby, University of Montana; G. Ledbetter, Mesa State College; and D. Armstrong, National Naval Medical Center.

This investigation was to determine the effects of carrying a load on the time required for evacuation along a simulated escape route (transit time). Subjects (eight males, weighing an average of 181 lbs [82.2 kg] and five females weighing an average of 145 lbs [65.8 kg]) completed two long field hikes in random order on two successive days; one hike with and one hike without a field pack. Field trials were conducted on Storm King Mountain near Glenwood Springs, CO (site of the 1994 South Canyon Fire). The dirt trail was 2,172 ft (660.5 m) long with a vertical gain of 450 ft (137 m), yielding an average grade of 20.75 percent. Subjects carried a calibrated portable metabolic system (Cosmed K4 or Aerosport VO2000), a fire shelter, and a Pulaski. During the pack trial, subjects also carried a 35-lb (15.9-kg) field pack. Blood samples collected before and 2 minutes after exercise were analyzed for lactate (Accusport lactate analyzer). Data were analyzed using a mixed-design ANOVA (analysis of variance) with repeated measures and planned comparisons (Table 2).

Men were 21.5 percent faster without a pack and women were 26.3 percent faster. For the males, mean and peak VO_2 were higher during the no-pack trial. The difference in blood lactate (at peak exertion and at rest) was significantly higher during the pack trial for the male subjects. Similarily, ratings of perceived exertion (RPE) were significantly higher for males during the pack trial (19.8) compared to the no-pack trials (18.7). In contrast there were no significant differences in ratings of perceived exertion for the females (20.0) for the pack trial compared to the no-pack trials (19.6). Simple regression analysis revealed a significant negative correlation between body weight and the slower times during the pack trials (*r* = -0.64), indicating that larger subjects were less affected by the pack. High correlations between peak VO_2 and transit rates were noted (*r* = 0.82 for the pack trial, *r* = 0.87 for the no-pack trial), indicating the contribution of aerobic fitness to quick escapes.

These data indicate that carrying a pack significantly impedes ground travel during a forced evacuation. The elevated blood lactate, heart rate, and ratings of perceived exertion responses coupled with the peak VO_2 levels indicate near-maximal effort and an emphasis on glycolytic energy production (data were collected at an elevation of about 7,000 ft). The

Finger stick for blood lactate analysis at end of simulated escape route evacuation.



Subject nears end of simulated escape route evacuation.

Table 2—Pack and no-pack trials of escape route evacuation.

	Time (min)	Mean VO_2 (mL/kg-min)	Peak VO_2 (mL/kg-min)	Heart rate (beats/min)	Lactate peak - rest (mmol)
Pack					
Male	10.7	41.1	48.6	181	9.8
Female	13.7	32.5	42.5	188	5.8
No Pack					
Male	8.4*	46.0*	52.1*	177	5.8*
Female	10.1*	35.1	41.1	188	5.8

** The probability that the difference between carrying a pack and not carrying a pack is due to chance is less than 0.05.*

data also show that larger individuals and those with higher levels of aerobic fitness are better able to negotiate the escape route. Finally, the results support the recommendation that wildland firefighters should abandon their packs during evacuations along emergency escape routes. (Supported by the Missoula Technology and Development Center and a collaborative research grant from Mesa State College, Grand Junction, CO).

Note: This study supplements previous estimates of the effect of carrying a load on escape route evacuation. Earlier estimates based on moderate loads and hiking speeds indicated a 15 to 20 percent faster time without pack and tool. With higher speeds or heavier loads, dropping the pack could increase speed by up to 30 percent, based on those estimates. Subjects in this study on Storm King Mountain were instructed to hike as fast as possible. Results indicated they could travel 21.5 to 26.3 percent faster without the 35-lb pack, but with a tool that could be used to clear a site for shelter deployment. The data also provide clear support for requiring firefighters to maintain a minimum level of aerobic fitness for safety reasons.

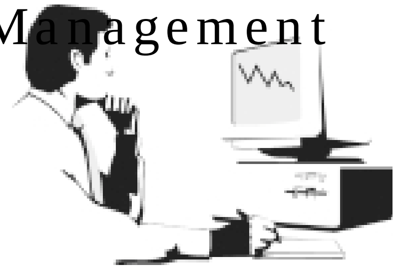
Analysis of Predictive Tests of Aerobic Fitness for Wildland Firefighters.

M. Strickland and S. Petersen, University of Alberta.

This study compared two field tests commonly used to predict aerobic fitness in wildland firefighters with direct measures from laboratory testing. Forty-five males (average age of 25.2 years with a VO_2 max average of 53.6 mL/kg-min) completed a treadmill test for ventilatory threshold (VT) and VO_2 max test, the Leger 20-m shuttle run, and the pack test (3-mile [4.8-km] hike with 45-lb [20.5-kg] pack) on separate days. The mean highest shuttle run stage completed was 9.5 sec and the time to complete the pack test was 41.6 min. Heart rate (HR) and blood lactate concentration from the pack test were significantly lower than values observed at the ventilation threshold, but perceived exertion ratings (RPE) were similar. The heart rate and ratings of perceived exertion at the end of the shuttle run were not significantly different than at the end of treadmill test, but peak blood lactate was significantly lower after the shuttle run than after the treadmill test. Shuttle run performance was significantly correlated with both VO_2 at the ventilation threshold (r = 0.69) and VO_2 max (r = 0.91). Lower but significant correlations were found between pack test time and VO_2 at the ventilation threshold (r = -0.47) and VO_2 max (r = -0.65). While the shuttle run is a better predictor of aerobic fitness, the pack test involves other aspects of work capacity (such as muscular fitness) related to wildland firefighting tasks. (This paper, supported by Alberta Environmental Protection, was presented at the annual meeting of the Canadian Society for Exercise Physiology in 1999).

Note: Dr. Petersen reports that when 22 female subjects were added to the sample, analysis confirmed that a 45-min time on the pack test was equivalent to a VO_2 max (aerobic fitness) of 45 mL/kg-min. The correlation between the pack test and VO_2 max for this larger sample (n = 67) was -0.7. The VO_2 max is a measure of maximum intensity. Wildland firefighting is an endurance event that demands aerobic fitness (VO_2 max), muscular fitness, and the ability to sustain work output across long work shifts.

Risk Management



The daily habits of people have a great deal more to do with what makes them sick and when they die than all the influences of medicine.
L. Breslow, M.D.

The seven habits research has associated with health and longevity, include: regular exercise, adequate sleep, a good breakfast, regular meals, weight control, abstinence from smoking and drugs, and moderate use of alcohol.

In other words individuals are responsible **for their health.**

Human Factors

The Wildland Firefighter Safety Awareness Study identified a number of strategies to address human factors, including: prevention of fatigue, accurate assessment of fatigue and health, recognition of differing capabilities of crews, and fostering physical fitness for the job. A 1999 General Accounting Office report on federal wildfire activities identified issues that could affect the agencies' ability to manage firefighting programs, including the shrinking wildfire workforce. And a Brookings Institute study has identified physical fitness reguirements as one of the most important issues in its study entitled, *"Where Have All the Firefighters Gone?"* In addition to a loss of expertise due to the retirement of an aging workforce, fire managers are faced with a precipitous decline in the fitness and health of the existing and prospective firefighters.

In recent years the United States has become the fattest nation in the world, with 55 percent of the adult population overweight or obese! Adult onset diabetes is appearing in teenagers. When doctors examined teenage hearts donated after accidental deaths, they found one in six already showed the blockages and plaque deposits of coronary artery disease. These alarming developments cannot be blamed on genetics. Studies of genetically similar Pima Indians living in Arizona and Mexico indicate a greater incidence of obesity and diabetes in Arizona. Obesity expert Claude Bouchard blames the epidemic of obesity on an increase in caloric intake and a decrease in caloric expenditure. In other words, Americans are eating too much and exercising too little. The excess calories are stored as fat.

Toxic Food?—**Americans are eating more fast food and prepared foods, with high levels of fat and calories. Brownell has coined the term "Toxic Foods" to describe the effects of a steady diet of high-fat foods. Schools are leasing lunch programs to fast food outlets, or kids go to the mall for a burger, fries, and shake (1,500 calories and 50 grams of fat). With both parents working, more meals are eaten out or ordered in. The result is a steady diet of toxic food, high in fat and calories, and low in nutrients. In addition to the effects of overweight on everyday life, the excess fat inhibits the action of insulin and increases the risk of diabetes. The fat and excess calories raise the blood lipids (cholesterol and triglycerides), leading to an increased likelihood of heart disease. This epidemic of obesity and inactivity will result in staggering health care costs in the future. The immediate effects include a decline in fitness and work capacity.**

Fit to Work?—**Candidates for firefighting jobs reflect the national trend toward higher weight and lower fitness. Children, teens, and adults spend their hours sitting in school or at work, in front of computers, TV's, and video game displays. No national program is in place to reverse the alarming decline in physical activity. As a consequence, few workers are equipped with skills and experience in arduous work. Fewer still come to a job work hardened, or with effective work habits. Overweight and inactivity combine to reduce fitness and work capacity. Excess weight is a handicap that increases metabolic heat production and heat storage, making the job tougher and the worker more prone to heat disorders.**

While lower levels of work capacity may be accommodated in jobs where mechanical assistance is possible, they pose a risk to the health and safety of wildland firefighters. Firefighters work in remote locations where accommodations cannot be used. They must wear protective clothing, and carry

gear, water, and tools weighing over 30 pounds. They must negotiate difficult terrain, under extreme environmental conditions. And they are expected to perform useful work. When emergencies arise, firefighters must be able to take care of themselves and to help others if necessary. Those who lack the capacity risk their lives and the lives of those who stay behind to help (see the Ruby, Ledbetter, and Armstrong study on safety zone evacuation).

Participants at the Wildland Firefighter Health and Safety Conference (1999) made a number of recommendations to improve the health, safety, and productivity of the work force. They endorsed the use of the work capacity test (pack test) for firefighters, and recommended mandatory participation in fitness programs for seasonal and full-time employees engaged in wildland fire suppression. The pack test defines the minimal level of work capacity for wildland firefighting. Higher levels of work capacity are needed to sustain work output all day under difficult environmental conditions, to stand up under repeated days of arduous work, and to meet unforeseen emergencies. Fire managers have higher performance expectations for Type I crews. Yet current work capacity requirements do not differentiate between the capabilities of Type I and Type II crews. Participants at the Wildland Firefighter Health and Safety Conference recommended the review and possible improvement of crew standards.

Wildland firefighting is tough work, and it may be getting tougher. Proposed increases in the use of prescribed fire have the potential to extend the fire season to more than 6 months for some workers. To maintain the health and safety of the work force, fire managers need to resist efforts to lower work capacity standards. They should make the standards known to potential recruits and help them meet the standards. Field data and experience indicate that high standards attract fit, motivated workers to fire crews. Low standards damage morale, decrease productivity, and risk the health and safety of the work force.

Fitness and Injury

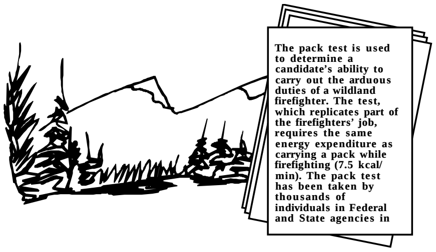
A study of 861 male and female U.S. Army trainees indicates that the fittest workers (measured by pushups, situps, and 1- and 2-mile runs) have the lowest injury rates. Women recruits experienced twice as many injuries as men, with 57 percent of the females experiencing one or more injuries compared to just 27 percent of men. The risk of serious injuries was almost 2.5 times higher for females than for males. The study's authors, Hemenway and others, indicated that the gender-injury relationship appears to be explained by physical fitness, especially aerobic fitness. The slowest runners experienced more sports injuries and the fastest runners experienced the fewest, regardless of gender. This study agrees with a 1999 study of Australian Army recruits by Pope and others that found a negative association between fitness and injuries. In another Australian study a modified physical training program reduced injury and medical discharge rates for male recruits, but not for females. The authors, Rudzki and Cunningham, recommended fitness standards for recruits entering the service.

Obesity and Asthma

As the prevalence rates of obesity and asthma increase, recent studies have detected a link between the conditions. Using data from the Nurses Health Study, a cohort of 85,911 female registered nurses, from 26 to 46 years old, researchers correlated asthma with obesity as indicated by the body mass index (BMI = weight in kilograms divided by the square of height in meters). The results showed a strong positive association between BMI and the risk of adult-onset asthma. Women who gained weight after age 18 were at significantly increased risk of developing asthma during the 4-year followup period.

Note: Obesity is defined as a BMI above 29. See BMI chart in Sharkey, B., *Fitness and Work Capacity*, NFES 1596, 1997.

Field Notes



Immune Friendly Nutrients

In addition to adequate energy, a number of nutrients have been found to enhance the function of the human immune system. They include:

Vitamin C-**(citrus fruits, broccoli, peppers) enhances immune response.**

Vitamin E-**(whole grains, wheat germ, vegetable oil) stimulates immune response.**

Beta Carotene-**(carrots, sweet potatoes) stimulates natural killer cells.**

Vitamin B6-**(potatoes, nuts, spinach) promotes white-cell proliferation.**

Folate-**(peas, salmon, romaine lettuce) increases white-cell activity.**

Selenium-**(tuna, eggs, whole grains) promotes antibacterial action.**

Zinc-**(eggs, whole grains, oysters) promotes wound healing.**

Several of these nutrients (Vitamins C, E, and B-carotene) also serve as antioxidants. (From B. Sharkey, *Fitness and Work Capacity*, NFES 1596, 1997).

Note: For a comprehensive list of nutrients that influence the immune system see the complete text of Dr. Steve Woods' article in the MTDC publication *Wildland Firefighter Health and Safety: Recommendations of the April 1999 Conference*.

Pack Test

The pack test is used to determine a candidate's ability to carry out the arduous duties of a wildland firefighter. The test, which replicates part of the firefighters' job, requires the same energy expenditure firefighting tasks (7.5 kcal/ min).

The pack test has been taken by thousands of individuals in Federal and State agencies in the United States, Canada, and Australia. Even though more than 90 percent of the candidates pass the test, it has been criticized as too difficult, the pack (45 lb) as too heavy, and the pace (4 mph) as too fast. Smokejumpers carry 110 lb for 3 miles to qualify for duty. Female Army recruits have been trained to carry 75 lb at 4.4 mph. Marines routinely carry 75 lb in awkward Alice packs, even on snowshoes. A recent article in the journal *Military Medicine* recommends a backpack run test, a 2-mile run with a 66-lb pack, as "a model for a fair and occupationally relevant military fitness test." According to the authors, the backpack run test uses standard-issue equipment, eliminates body size bias, and measures work- and health-related components of fitness.

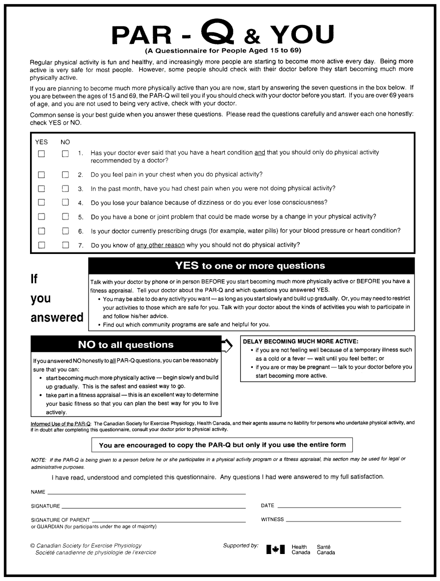
Wildland firefighters are told not to run while taking the pack test. The pack test is a pass/fail test. Running is not necessary to pass: doing so increases the risk of injury.

Candidates for the pack test should be reminded of proper lifting techniques and the need to warm up and stretch before beginning the test. Candidates should follow all safety instructions, wear a comfortable pack, hike with an upright posture, and avoid extreme body positions (such as crouching or leaning). Finally, candidates should be told they are free to stop at any time for any reason. Candidates should train before taking the test.

Fitness for Firefighting

Like athletes, serious firefighters realize that physical activity and training are a year-round commitment. Job-specific training and work hardening should begin weeks

before taking the pack test. Before training, candidates should complete the PAR Q or an equivalent health-screening questionnaire. They should consult a physician if they are over 45 years of age or if the questionnaire indicates that they should do so.



PAR - Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7. Do you know of any other reason why you should not do physical activity?

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

You are encouraged to copy the PAR-Q but only if you use the entire form

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

NAME ____________________

SIGNATURE ____________________ DATE ____________________

SIGNATURE OF PARENT ____________________ WITNESS ____________________
or GUARDIAN (for participants under the age of majority)

Supported by: Health Canada Santé Canada

Begin specific training for the pack test at least 6 to 8 weeks before taking the test and reporting for duty. Train by hiking or power walking using the ankle-height footwear that will be worn during the test. Pack test candidates should:

- Hike a 3-mile flat course without a pack. When they can cover the course in less than 45 minutes, they should carry a 25-lb pack on training hikes.
- Increase the pack weight until they can hike 3 miles in 45 minutes with a 45-lb pack.

Candidates can also:

- Hike hills (with a pack) to build leg strength and endurance.
- Jog the flat course (without a pack) to build aerobic fitness.
- Cross-train (mountain bike, lift weights) to build stamina and strength.

(For more information about training, see B. Sharkey, *Fitness and Work Capacity*, NFES 1596, 1997.

Technical Committee Meets

Members of the Wildland Firefighter Health and Safety Technical Committee met in Indianapolis during the June annual meeting of the American College of Sports Medicine. They discussed current research, recommended research priorities, and planned field studies. In addition, the committee will meet by teleconference and may hold a fall meeting to plan Fiscal Year 2001 field studies.

Publications

Wildland Firefighter Health and Safety Report: No.1. **2000. Missoula Technology & Development Center, (0051-2825, call 406–329–3978).**

Coming up. . .

In the next Wildland Firefighter Health and Safety Report:

- **Heat Stress**
- **Hydration**
- **Uniforms and Heat Stress**
- **Drugs and Heat Stress**

If you have comments, questions, or suggestions about this report or project send them to bsharkey@fs.fed.us.

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