

The Forest Service has recognized that physical fitness and diet are important components of maintaining firefighter health and safety (Sharkey 1997b). Wildland firefighters expend large quantities of energy in an environment containing atmospheric pollutants from burning vegetative material. They may experience intermittent or altered dietary patterns while fighting fires. Research involving occupational specialties that share oxidative stress risk factors similar to firefighters (a diet low in fruits and vegetables, high levels of physical exertion, sunlight exposure, and smoke inhalation) leads us to predict that firefighters may also experience increased free radical formation and therefore might benefit from antioxidant supplementation (Figure 7). Certain types of military training are similar to the rigors of wildland firefighting. Preliminary studies of U.S. Army Ranger training and U.S. Marine Mountain Warfare training indicate that these individuals may be under increased levels of oxidative stress and might benefit from supplemental antioxidants (Shippee 1999, Pfeiffer et al. 1999, Chao et al. 1999).

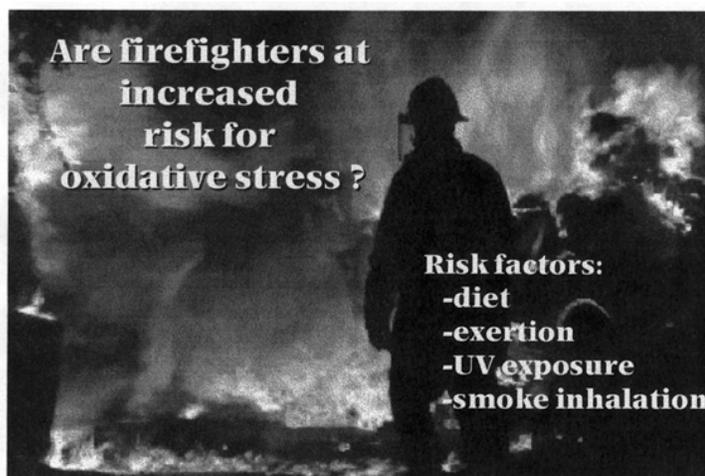


Figure 7—Are firefighters at increased risk for oxidative stress?

Research is needed to establish if wildland firefighters are indeed under excessive levels of oxidative stress and to investigate their response to supplemental antioxidants. Until such research can be accomplished, it is advisable to take a conservative approach that includes both diet and exercise as preventive measures (Figure 8). As recommended in the USDA Forest Service

What can I do to lower my level of oxidative stress?

Exercise training

- Boosts levels of antioxidant enzymes

Diet

- Five servings of fruits and vegetables per day

Dietary Supplements

- Vitamins A (beta carotene) C, & E
- Phytochemical antioxidant supplement

Figure 8—Recommendations to lower oxidative stress levels in firefighters.

report, "Fitness and Work Capacity" (Sharkey 1997b), firefighters should be in excellent physical condition, participate in regular aerobic and strength training, and pay close attention to their diet. These steps will ensure high levels of antioxidant defense enzymes and nutrients in their tissues. Their normal diet should include at least five servings of fruits and vegetables each day. During extended periods of training or actual firefighting, the catering service should be encouraged to supply foods that contain high levels of antioxidant nutrients. Fruits, fruit juices, and vegetable juices are appealing to most people even under adverse field conditions and are good sources of antioxidant nutrients. Serious consideration should be given to providing supplemental antioxidants during field training and firefighting. These supplements could be provided in beverage or tablet form. The potential for antioxidant supplementation to cause harm is low. Supplementation has significant potential short- and long-term benefits. A possible exception may be heavy cigarette smokers, who should avoid supplements containing high levels of beta carotene, due to its association with increased risk of cancer (Diplock 1997).

Firefighters share many of the risk factors that are associated with increased oxidative stress in other populations (Figure 9). Research to directly document the influence these risk factors on firefighter health is lacking. Until such research is accomplished, a prudent and conservative approach should be adopted to emphasize increased dietary and possibly supplemental intake of antioxidant nutrients for firefighters.

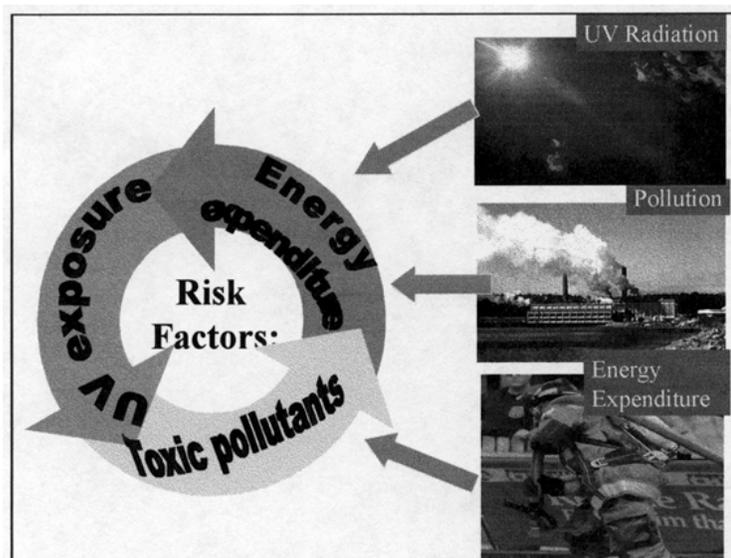


Figure 9—Summary of risk factors.

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Individual Factors Related to Health, Safety, and Performance

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The ability to perform hard (arduous) work for protracted periods of time can be related to a number of physical and psychological factors. These factors can override demographic factors such as gender, race, or ethnicity. Some of these factors, listed in no particular order of importance, are:

- Physical size and body composition
 - Lean body weight
 - Fat weight
- Personal fitness and fitness factors
 - Strength
 - Stamina
 - Muscular endurance
 - Acclimatization
- Motivation
- Nutritional Status
 - Hydration
 - Energy substrates
- Age
- Psychological state (fatigue)
- Overall health status (wellness)

Some of these factors are controllable, others are inherited, and still others change with the environment. Recognizing that we have no control over the environment, what factors can we address?

With all of the published research on the benefits of regular exercise, you would think that people would embrace the concept that the human body was meant to be used. While we can't guarantee that there's a one-for-one relationship between fitness and longevity, for fit persons the quality of the life is clearly more vibrant and productive. The direct benefits to increased productivity on the job is well documented.

We might ask the same question of the well-established relationship between smoking and a host of diseases and disorders. Knowing what we do, why do people choose to do the things they do? Said another way, the physiological basis for improving performance and health is well known. What's really needed is more research on how to motivate people to avoid self-destructive behavior such as smoking or sedentary lifestyles.

In terms of demographic factors, research does not lend support to physical performance limitations based on race or ethnicity. Studies of gender differences indicate the obvious: women are, on average, smaller than men, and they have much less upper body strength (50 to 60% of the upper body strength of men). The average woman has a lower aerobic fitness (39 to 40 ml/kg-min for young women compared to 45 to 48 ml/kg-min for men). This means that when job demands are arduous, as they are for wildland firefighters, more women will have to train to be able to accomplish work tasks, while maintaining a reserve to meet unforeseen emergencies.

Age

For the balance of this paper, I would like to examine a topic that has been of great personal interest to me: aging. Aging is relevant because all of us are on this planet together, and no one is getting off alive. We all have the same amount of time per day. We are basically captives of the 24-hour day.



Age has been used in making hiring decisions for many years. The Age Discrimination in Employment Act (ADEA) developed a protected class (persons from 40 to 70 years old). For persons within the protected class, employers could only use age for decision-making when they could show that it constituted a BFOQ (bona fide occupational qualification). Most of us operate on the principle that there is a decline in performance with advancing age. This is true. No one reverses the aging process, no matter what you may hear. But, we can certainly slow and temporarily halt the process by adhering to a well-established scientific principle called the General Adaptation Syndrome (GAS).

What the GAS says is that if you don't use a certain physiological system, you lose it. Conversely, if you use a system, it gets stronger. This is the underpinning of physical conditioning. If we stress a system to the point of fatigue, it rebounds and actually becomes stronger. Clearly, there are limits. All Olympic athletes strive to optimize all of their systems, allowing them to perform beyond any previously demonstrated level.

So what are the implications for wildland firefighters? Looking again at the factors that have been demonstrated to distinguish differences in work output and personal performance, alterations and improvements can be shown in the following areas:

- Physical size and body composition
 - Lean body weight is increased through physical exercise (strength or resistance training)
 - Fat weight (both total percent fat and total fat weight) is reduced, resulting in less “dead weight” to be hauled around, reducing the burden on the heart to pump blood or otherwise support mass that is not contributing to productivity)
- Personal fitness and fitness factors
 - Strength: If I train the neuromuscular system, then I will get stronger. Lifting objects now takes less of my functional reserve.
 - Stamina: Cardiovascular fitness (the ability to take up and utilize oxygen) has a host of benefits beyond the simple improvement of one's functional work capacity. Training the cardiovascular system sets in motion a host of positive effects such as lowered heart rate while at rest or while performing sustained tasks that previously resulted in fatigue.
- Muscular endurance
 - Muscular endurance (not to be confused with heart-fitness) are those repetitive muscle-contractions that are typically finite in nature (we usually measure them in repetitions to failure). Adaptations from training in this area are among the fastest to improve and the easiest to sustain.
- Acclimatization
 - The body adjusts to the effects of heat and altitude.
- Motivation
 - The fitter individuals have already demonstrated that they are personally motivated. They feel that they have a locus of control that starts within themselves. Think of it this way: they know how to budget time and have organized their day to include personal time that directly benefits them.
- Nutritional Status
 - Hydration: No matter how fit you are, when you're out of fluid, you're out of gas. Paying attention to personal hydration status is critical. There may be no edge for the fit person, other than, hopefully, they've learned that you need a minimum of 1 quart of fluid for every 60 minutes of hard work.
 - Energy substrates: The fit person is better able to store (supersaturate) fuel at the cell level than the unadapted individual. Again, score another point for the fit person.
- Age
 - Medical science has amassed evidence that individuals may actually “choose not to age.” Said another way, while you can't stop the superficial process of graying hair or the wrinkling skin, you can preserve and extend your underlying “functional work capacity.” The human organism is a wonderful machine that, unlike man-made machines, is better maintained with use.
 - The normal age-associated decline in aerobic fitness, one important dimension of firefighter fitness, is approximately 1% per year, or 10% per decade for the sedentary population. In physically active individuals, the loss is approximately 13% across the span of 25 years.
 - In a study funded by the U.S. Fire Administration examining the relationship between physical performance measures and job performance, increasing amounts of body fat were more harmful to performance than was advancing age.

- Psychological state (fatigue)
We all need sleep and rest; without rest, work performance goes down markedly and ultimately halts. The fit person can do more work in less time and takes less time to recover.
- Overall health status (wellness)
Wellness is a term that lacks objectivity. We can't measure it in terms like pounds, or milliliters per minute. But the fit individual has a certain vibrancy, resistance to fatigue, resistance to disease and savoir-faire. If you've been there then you know what I'm talking about. If you haven't, then the good news is that you can experience the personal benefits of fitness. It's a challenge that's available to everyone walking the face of the earth.
- Ethnicity and race
Laboratory or field studies do not support differences in performance related to ethnicity or race.
- Gender
Because of factors such as body size (lean body weight), and muscular and aerobic fitness, some men and women will have to train to meet job demands.

In Summary

- The job of firefighter does not change as a consequence of advancing age (the fire doesn't know or care who's making the attack).
- Aging is inevitable, but the loss of physical work capacity is significantly diminished through regular programs of physical activity.
- The use of a physical performance tests can answer the question "Can you still safely perform the essential functions of the job?"
- It is possible for firefighters to maintain the capacity to perform arduous work into their 60's; however, this will not occur without regular exercise as a part of their lifestyle.
- Individuals who meet only minimum levels of fitness upon entering a firefighting career are not likely to realize a service-connected retirement.

Youth is not a time of life, it is a state of mind. It is not a matter of rosy cheeks and supple knees but a matter of will, a quality of imagination, a vigor of emotions, an appetite for adventure over the love of ease. This often exists in the man of 60 more than in the boy of 20.

Samuel Ullman

Conference Program

Mon. 4/26

1800 Arrive, register, informal social

Tues. 4/27

0800 Registration

0830 Welcome Brian Sharkey, MTDC

0840 Director's Perspective Jose Cruz, F&AM

0900 Defining the Issues: Dick Mangan, MTDC, Dave Aldrich, F&AM

0930 **Session 1. Firefighter Health and Safety**

0930 Presentation: **Illness, Injuries, and Fatalities**
Dick Mangan, MTDC

1000 Break

1020 Panel **What We Need to Know About Illness, Injuries, and Fatalities**
D. Mangan, Ron Wilson, Chuck Whitlock, MTDC

1100 Discussion: **Ways to Reduce Illness, Injuries, and Fatalities**

1145 Lunch

1300 **Session 2. Job Requirements/Issues**

1300 Presentation: **Demands of the Job**
Brian Sharkey, Ph.D., MTDC

1330 Presentation: **Energy Demands of Wildland Firefighting**
Brent Ruby, Ph.D., U of Montana

1400 Panel: **What We Need to Know About Work-Related Issues and Health**
B. Ruby, B. Sharkey, Leslie Anderson, Steve Karkanen

1430 Discussion: **Should Job Requirements Be Changed?**

1500 Break

1520 **Presentations, Posters, and Products**

1700 Adjourn

1900 Informal discussions among participants

Conference Program

Wed. 4/28

0800 Session 3. The Working Environment

0800 Presentation: **Heat Stress**
Brian Sharkey, Ph.D., MTDC

0830 Presentation: **Health Hazards of Smoke**
NWCG Video

0900 Panel: **What We Need to Know About the Working Environment**
B. Sharkey, B. Ruby, Roger Ottmar, Dave Custer

0930 Discussion: **What Can We Do to Improve the Working Environment?**

1000 Break

1020 Session 4 Factors That Influence Health

1020 Presentation: **Firefighting and the Immune Response**
Steve Wood, Ph.D., Ross Laboratories

1050 Presentation: **Oxidative Stress in Firefighting**
Wayne Askew, Ph.D., U of Utah

1120 Panel: **What We Need to Know About Firefighter Health**
W. Askew, S. Wood, Mark Vore, Paul Broyles

1200 Lunch

1300 Discussion: **What Can Be Done to Ensure Firefighter Health?**

1330 Session 5 Factors Related to Health, Safety, and Productivity

1330 Presentation: **Individual Factors Related to Health, Safety, and Productivity**
Paul Davis, Ph.D., Applied Research Associates

1400 Panel: **Ways to Improve Health, Safety, and Productivity**
P. Davis, Becky Livingstone, Teresa Bellinger, Ph.D.

1430 Discussion **Issues Related to Individual Factors**

1500 Break

1520 Working Groups: Organization and ground rules:
Avoiding illness, injuries, and fatalities
Job requirements/issues (shift length, work/rest guidelines)
The working environment (heat, smoke, uniforms, tools)
Nutrition/energy
Individual Factors (gender, age, fitness)

Conference Program

1600 Working Groups: Initial meeting

1700 Adjourn

Thurs. 4/29

0800 Announcements

0810 Working Groups: Meet to discuss/develop specific recommendations

1000 Break

1020 Combined Groups: Review progress

1100 Working Groups: Finalize recommendations

1200 Lunch

1300 **Combined Groups: Meet to prioritize recommendations in areas of:**
Research and development
Environmental safeguards, uniforms, PPE
Nutritional guidelines, supplements, catering contracts
Work/rest, shift length, and other guidelines
Health habits, stress management
Employee selection/training
Medical screening

1600 Adjourn

Thurs. p.m.

Fri. a.m. Optional Tours: Smokejumper Training Center (Tony Petrilli)
Intermountain Fire Sciences Laboratory
University of Montana Human Performance Lab (Dr. Ruby)

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Brian Sharkey completed a Ph.D. in exercise physiology at the University of Maryland before coming west to join the faculty of the University of Montana and begin a long association with MTDC. His work for the Forest Service has included research and development on fitness tests and programs, heat stress, hydration, nutrition, protective clothing, tools, work/rest cycles, employee health (wellness), and more.

A researcher, author of several books, and past president of the American College of Sports Medicine, Dr. Sharkey practices what he preaches, participating regularly in running, mountain biking, cross-country skiing, backpacking, canoeing, and other pursuits. His work has recently been honored with a USDA Distinguished Service Award, and a Forest Service Technology Transfer Award.

Library Card

Sharkey, Brian, ed. 1999. Wildland firefighter health and safety: recommendations of the consensus conference, April 1999. Tech. Rep. 9951-2841-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 74 p.

Presents the recommendations and key papers from a conference on wildland firefighter health and safety held in Missoula, MT, from April 27 to 29, 1999. Topics covered during the conference included: firefighter health and safety, job requirements and issues, the working environment, factors that influence health, and factors related to health, safety, and productivity.

Keywords: fire fighters, fire fighting, heat stress, illness, immune response, job performance, occupational health, safety at work

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