



THEME

GPs and the environment



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Fighting with fire

How bushfire suppression can impact on fire fighters' health

BACKGROUND

Each year bushfire threatens Australia's rural, forest, and urban-rural areas. Australia's rural fire fighters work to curtail this threat in hot, smoky conditions, often at risk to their physical health. General practitioners, especially in rural areas, can help preserve the health of fire fighters during the fire season by understanding the stressors they face on the fireground.

OBJECTIVE

This article outlines how the key fireground stressors of work intensity and duration, heat (from the weather, the fire, and the fire fighter's own exertion) and smoke impact on the health of fire fighters. Practical advice for GPs treating Australia's rural fire fighters is also included.

DISCUSSION

General practitioners can help preserve fire fighters' health during bushfire suppression in a number of ways, including: identifying fire fighters at risk of cardiac distress during physical labour and educating them about the early warning signs; advocating regular exercise; discouraging smoking; and promoting the benefits of maintaining fluid, carbohydrate, and electrolyte levels during a shift.

Australia is one of the most bushfire prone countries in the world.¹ Fire fighters from Australia's regional fire brigades and land management agencies protect people and property from the annual bushfire threat. Fire fighters work long hours in hot, smoky conditions, often at risk to their physical health. Preserving fire fighters' health is the responsibility of fire agencies and their operational personnel and occupational health and safety staff, in consultation with medical practitioners who have experience in occupational medicine. Occupational health and safety services are often centrally administered, limiting access for fire fighters living in remote communities. Therefore, fire fighters may turn to their local general practitioner for advice and treatment to ensure they are fit and ready to fight the next fire.

Work intensity and duration

Rural fire authority and land management agency fire crews work 8–14 hour shifts when fighting bushfires.² Fire brigades primarily use fire tanker hoses and knapsacks to deliver water and fire suppressants onto the fire. Land management crews use rake-hoes, chainsaws, and axes to

clear low lying vegetation, creating firebreaks to manage fire spread. Intensity of work for fire authority and land management agency crews is variable.² Long periods of 'moderate' (50–69% of age predicted maximum heart rate [HRmax]³) level labour are interspersed with brief bouts of 'hard' (70–85% HRmax) labour.^{2,4}

Cardiovascular risk

Intermittent hard work efforts can trigger ischaemic cardiac events, especially in middle aged men³ who comprise the majority of Australia's bushfire fighting force.⁵ The risk of dying during physical exertion is low; estimated at six deaths for every 100 000 exercising middle aged men.³

Victoria's Country Fire Authority (CFA) reported seven heart attacks across all firefighting activities from 1995–2004.⁶ The Tasmania Fire Service (TFS)⁷ and South Australia Country Fire Service (CFS)⁸ reported no heart attacks since 2001 and 2003, respectively. Fire agency heart attack data may not completely illustrate the cardiovascular strains of firefighting.⁹ Fire agencies do not collect data on cardiac events that occur after the fire fighter has completed their assigned shift. Furthermore, early warning signs such as chest pain/angina, increased fatigue, sensation of

Table 1. Cardiovascular disease risk factors³

Positive risk factors	Defining criteria
Age	a. Men >45 years of age b. Women >55 years of age (or with premature menopause without oestrogen therapy)
Family history	a. Father, brother, or son suffering heart attack or sudden death before 55 years of age b. Mother, sister, or daughter suffering heart attack or sudden death before 65 years of age
Current cigarette smoking	
Hypertension	a. Blood pressure $\geq 140/90$ mmHg, confirmed by measurements on two separate occasions b. Currently taking antihypertensive medication
Hypercholesterolemia	a. Total serum cholesterol >5.2 mmol/L ⁻¹ (200 mg/dL ⁻¹) b. High density lipoprotein (HDL) cholesterol <0.9 mmol/L ⁻¹ (35 mg/dL ⁻¹)
Diabetes mellitus	a. Insulin dependent diabetics over 30 years of age b. Insulin dependent diabetics longer than 15 years c. Noninsulin diabetics over 35 years of age
	Persons fitting criteria a–c should be classified as having cardiovascular disease and be referred to undertake a medically supervised maximal exercise test before engaging in vigorous work
Physical inactivity	No regular exercise or physically active recreational pursuits
Negative risk factor *	Defining criteria
High serum HDL cholesterol	HDL cholesterol >1.8 mmol/L ⁻¹ (60 mg/dL ⁻¹)

* If HDL cholesterol exceeds 1.8 mmol/L⁻¹ (60 mg/dL⁻¹), then subtract 1 from the sum of the positive risk factors, as high HDL decreases the risk of cardiovascular disease

indigestion/heartburn, and excessive breathlessness that often precede fatal cardiac events are frequently ignored and not reported.¹⁰

The risk of a cardiac event during physical exertion is increased for individuals who possess two or more cardiovascular risk factors (*Table 1*).³ The Australasian Fire Authorities Council recommends fire fighters with multiple risk factors undergo yearly examinations, ideally before the fire season.¹¹ The exact components of any such examination would be specific to the needs of each fire agency. Priorities for history, examination and investigation of rural fire fighters is included in *Table 2*. Individuals with known cardiovascular disease should undergo medically supervised maximal exercise tests before they engage in vigorous exercise.³ Although the majority of bushfire suppression work is not vigorous, brief periods of intense work are performed in most fireground shifts.² Unfit or usually sedentary individuals are also at increased risk of a cardiac episode when performing vigorous physical work they are unaccustomed to.¹⁰ Engaging in regular physical activity may reduce fire fighters' risk of cardiac distress during bushfire suppression.

Musculoskeletal injury

Fire fighters also risk musculoskeletal strains and sprains during bushfire suppression. Victoria CFA report that such ailments accounted for 41% of injuries from 1995–2004.⁶

Musculoskeletal injuries comprised 11% and 18% of all fireground injuries reported for the TFS and CFS since 2001 and 2003, respectively.^{7,8} The reason(s) for the inter-agency differences in injury rates is unclear.

Injuries to hips, knees, and ankles may arise from frequently stepping down from fire trucks, which produces impact forces equivalent to 3.2 times a fire fighter's body weight.¹² The joint stresses may be exacerbated by landing on uneven ground covered by downed trees and stumps, rocks, and loose debris. Poor visibility at night or in smoky conditions adds to the potential injury risk.

Overseas firefighting and military populations have reduced their injury rates by implementing aerobic fitness, muscle strength, and flexibility programs.^{13,14} Improvement in lower back flexibility and core stability may further limit injuries.^{15,16} Regular exercise, comprising endurance, strength, flexibility, and core stability activities may also reduce the risk of musculoskeletal strains and sprains during a fire season.

Heat

Bushfires occur in hot, dry weather and produce extreme radiant heat. The heat stress is further increased by the fire fighter's own exertion and their personal protective clothing. The combined heat load for Australia's rural fire fighters increases their risk of heat exhaustion, which renders them unable to continue work. Heat related

ailments accounted for 2–6% of all fireground injuries reported by CFA, TFS, and CFS fire fighters from 2003–2006.^{6–8}

Heat exhaustion can be prevented by increasing physical fitness, losing excess body fat, and acclimatising to work in warm to hot weather before the fire season.¹⁷ Sunburn, alcohol consumption, recent illness, and dehydration all increase the risk of heat exhaustion during physical work.¹⁷

Fire fighters can reduce their susceptibility to heat exhaustion by regularly consuming commercially available sport and electrolyte replacement drinks during their shift. The dilute mix of water, electrolytes, and carbohydrate minimises fluid losses through urine and provides energy to work.¹⁸ When fluid is not replaced during physical work, the volume of blood is reduced, limiting the oxygen supply to working muscles and heat displacement to the skin.¹⁹ In response, core temperature and heart rate rise steadily until exhaustion.²⁰ The increase in heart rate raises the risk of cardiovascular strain during physical work.¹⁰ Modest increases in core temperature have been associated with a reduced work output, muscle weakness and a loss of balance.²¹ If core temperature continues to rise, the individual will stop sweating and can lose consciousness.²¹

Fire fighters suffering heat exhaustion require cooling, rest, and fluid replacement. The fire fighter should not

to be re-deployed to the fireground in the 48 hours after suffering heat exhaustion.¹⁷ In severe cases, the fire fighter should be examined by a GP and should return to the fireground after 14 days of working – without incident – in warm conditions, to properly acclimatise for bushfire suppression work.¹⁷

Smoke

Smoke exposure is unavoidable for bushfire suppression workers. Illness arising from smoke exposure comprises 2–8% of all fireground injuries reported by CFA, TFS, and CFS fire fighters from 2003–2006.^{6–8} Smoke inhalation 'sickness' is generally attributed to toxic air contaminants including carbon monoxide, respiratory irritants (particles, formaldehyde, acrolein) and volatile organic compounds (eg. benzene) found in bushfire smoke.²² Elevated carbon monoxide levels can lead to headaches, dizziness, and confusion that increase with the level of exposure.²³ The available data, although limited, suggests carbon monoxide levels in bushfire smoke rarely exceed occupational exposure standards.²² However, exposure may be increased during intense work efforts requiring higher ventilation rates, increasing the volume of air (and carbon monoxide) inhaled. Once inhaled, carbon monoxide prevents oxygen being released from the blood stream to the working muscles.²⁴ A lower oxygen supply reduces work output while increasing the heart rate, potentially increasing cardiovascular strain.²⁴

The exaggerated heart rate with carbon monoxide exposure may be particularly problematic for fire fighters with existing cardiovascular risk factors. Tobacco smokers are at further risk as the carbon monoxide from cigarettes and bushfire can aggregate, increasing exposure levels.²⁵ Respiratory particles can cause coughing, eye watering, and difficulty breathing. The contaminant levels associated with these symptoms have been identified in 30% of smoke samples obtained during small scale bushfires.²⁶ Prolonged or intense work in bushfire smoke may increase fire fighters' exposure to respiratory particles. Elevated exposure can impair lung function,²⁷ reducing the volume of air that can be inhaled and exhaled thereby limiting the fire fighter's work productivity.

Fire fighters who smoke tobacco or have recently quit smoking experience the greatest declines in lung function after working in a smoke filled environment.²⁸ Fire fighters suffering from respiratory ailments such as asthma, bronchitis, emphysema, or hay fever are also highly susceptible to decreases in lung function when particulate matter concentrations are high.²⁶ Exposure to human carcinogens formaldehyde and benzene appears to be low,²⁶ but more data from Australian bushfires is needed.

Table 2. Medical components for annual health check for rural fire fighters¹¹

General area	Specific tests
Anthropometry	Height
	Weight
	Body mass index
	Waist circumference
Respiration	Forced vital capacity (FVC)
	Forced expiratory volume in one second (FEV ₁)
	FEV ₁ /FVC ratio
Cardiovascular health	Resting heart rate
	Blood pressure
	Fasting total cholesterol
	Fasting high density lipoprotein cholesterol
	Fasting blood glucose concentration
Lifestyle	Physical activity levels
	Smoking (or not)
	Alcohol intake
	Current medication
Musculoskeletal	Injury history
	Posture
	Joint pain (particularly lower back)
Vision	Colour recognition
	Distance vision

Summary of important points

Fire fighters' health and safety is fundamental to safeguarding Australia from the annual threat of bushfire. Local GPs can aid fire and land management agencies by:

- initiating discussions with local fire brigade captains to review health and fitness issues (if any) being identified by brigade members
- delivering health and fitness information sessions to local fire brigade groups before, during, and following each fire season
- offering health and fitness appraisals to brigade members before and after each fire season
- educating fire fighters to recognise and report early warning signs of cardiac distress during physical exertion such as chest pain/angina, increased fatigue, sensations of indigestion/heartburn, and excessive breathlessness
- persuading fire fighters with two or more cardiovascular risk factors to undergo yearly medical examinations before each fire season
- referring fire fighters with cardiovascular disease to undergo a medically supervised maximal exercise test before the fire season
- encouraging fire fighters to undertake regular exercise including endurance, strength, lower back flexibility, and core stability activities
- promoting the benefits of acclimatising before the fire season by losing excess body fat and working in warm to hot weather
- educating fire fighters about the benefits of maintaining carbohydrate, electrolyte, and fluid levels on the fireground
- conducting a full medical examination for fire fighters who have suffered heat exhaustion
- persuading fire fighters to quit smoking
- instructing fire fighters on how to manage existing respiratory conditions especially before and during the fire season.

Resource

Bushfire Cooperative Centre: www.bushfirecrc.com/.

Conflict of interest: none declared.

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