

# FIRE NOTE

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## FIREFIGHTER HEALTH AND SAFETY



### SUMMARY

Each year, thousands of Australasian career and volunteer firefighters battle bushfires in both rural and rural-urban interface areas. In doing so, they face numerous hazards, including heat (from the fire, weather, and their own physical exertion), smoke, dust, noise and chemical agents. Furthermore, bushfire-suppression duties involve long working hours with periods of high-intensity physical labour. The combination of such stressors places considerable physiological, psychological and emotional strain on a firefighter, which may result in fatigue, impaired judgement, unsafe behaviour, accidents, injuries, and, in very rare cases, death.

The health and safety of firefighters is central to safeguarding the public from the annual devastation caused by bushfire. Australian firefighter health and safety has not, however, been thoroughly researched. This document reviews findings of Bushfire CRC research on firefighter health and safety risks, and explores how possible interventions, such as fitness for duty recommendations and hydration strategies, could mitigate firefighter health risks.

### ABOUT THIS FIRE NOTE

This document provides a current overview of the key findings to date from the Bushfire CRC Firefighter Health and Safety research project.

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### CONTEXT

The health and safety of firefighters is essential in preparing for, and the suppression of, bushfire which threatens the landscape on an annual basis. The Bushfire CRC research explained here examines the major health and safety risks which threaten today's firefighting community, and explores potential interventions that may help negate such risks.

### BACKGROUND

Volunteer and career firefighters from Australasia's fire and land management agencies conduct a wide variety of duties in preparation for, and the suppression of, bushfires. Recent statistics indicate that approximately 220,000 people act as volunteer members of Australia's rural fire agencies (REFERENCE 1). As these men and women provide the backbone of the nation's defence against bushfire, dedicated research devised to preserve firefighters' health and safety is vital for the sustainability of this service.

## BUSHFIRE CRC RESEARCH

The Bushfire CRC has been researching Australian firefighter health and safety throughout the last seven years in a cooperative effort between fire agencies and research providers. Volunteer and paid staff, primarily from fire-tanker based rural fire agencies, participated in the research. The most prominent findings in regards to firefighter health and safety risks are presented in this document, as well as possible interventions which could reduce the impact of such risks.

### Major Health and Safety Risks

In a review of five-to-10 year injury statistics from three fire agencies in south-eastern Australia, the leading causes of on-duty firefighter injuries were determined to be:

- Musculoskeletal strains and sprains (11-41 per cent) (8).
- Smoke exposure (2-8 per cent) (8).
- Heat stress (2-6 per cent) (8).

Overseas injury rates for least-fit firefighters have been shown to be 6.3 per cent higher than for their most-fit counterparts (9). Low levels of cardiovascular fitness have also been associated with increased injury risk during manual handling tasks (for example, manoeuvring charged hoses or using handtools such as a rake hoe or axe) (10). Also, increases in cardiovascular fitness and/or muscular strength have been shown to directly decrease the likelihood of injury in firefighters over a five-year period (11). As such, firefighter fitness is likely to be an extremely important element in promoting successful bushfire preparation and suppression.

### Firefighter Fitness Levels

Considering the impact that fitness levels could have on the firefighter population and subsequent bushfire management, the fitness levels of Australasian firefighters are not well documented. The small amount of research into this area suggests that the fitness of the firefighter population is no better than that of the general population for the corresponding sex and age group (12):

- Cardiovascular fitness levels of paid personnel are found to be no different from the 'average' fitness of the Australian population for that age range (12).
- Sixty-six per cent of the firefighters tested have two or more risk factors for cardiovascular disease (13).
- At least 50 per cent of male firefighters and 33 per cent of female firefighters over 40 years of age have an absolute coronary heart disease risk greater than 'low risk' for their age group and sex (13).



▲ This Bushfire CRC project tested firefighter fitness levels on the fire ground.

These statistics suggest problem areas, particularly given that rural firefighters must perform intense physical work bouts when fighting bushfires (8). Cardiovascular events such as chest pain, heart attack and stroke are often associated with physical over-exertion (10).

To determine the required fitness levels of rural firefighters, the level of cardiovascular fitness associated with their bushfire suppression duties needs to be determined. Fire agencies that can identify the cardiovascular fitness demands of key fireground tasks are able to recommend the fitness levels their firefighters should aspire to in order to complete their duties safely and productively. The American College of Sports Medicine (ACSM) states that cardiovascular fitness is determined by the frequency, intensity, duration and type (or mode) of activity performed (14). The Bushfire CRC research team sought to quantify the ACSM cardiovascular fitness factors with the aim of providing recommendations for the level of cardiovascular fitness necessary for firefighting duties.

### Key Fire Suppression Activities

Thirty-six volunteer firefighters (with an average of 21 years of experience) were surveyed in order to identify the type of tasks performed during bushfire suppression (15). The most physically demanding tasks identified by the volunteer firefighters included:

- Advancing and repositioning 38mm charged hoses (15).
- Using hand tools (such as rake hoe or axe) to create firebreaks or during blacking out activities (15).

Frequent, important and physically

demanding tasks are often termed 'critical' to job performance (16). The critical tasks highlighted during the survey process were characterised by carry, drag and dig actions (15). Respondents believed that the critical tasks challenged firefighters' endurance and strength-endurance capacities (15).

### Fire Suppression Task Intensity

Bushfire CRC research has shown that bushfire suppression duties comprise intermittent periods of intense work separated by longer periods of lower level labour and/or rest (17). The research has also shown that the work-rate for 'critical' fireground tasks (as identified in 'Key Fire Suppression Activities') reaches between 70 per cent to 95 per cent of firefighters' maximal age-predicted heart rate. This is classified as 'hard' to 'very hard' work by ACSM (14, 15, 17). Across a shift of 10 hours, firefighters' heart rates were found to reach 54 per cent (plus-or-minus five per cent) of their age-predicted maximum and peak at 92 per cent (plus-or-minus nine per cent) (17).

### Duration of Intense Work

Research investigating the durations spent at different work intensities is still in the preliminary stages. Analysis of the existing data suggests that 'hard' work efforts (with heart rates between 70 per cent and 90 per cent of maximal age-predicted heart rate) during bushfire suppression are sustained for between 20 to 180 seconds at a time, and occur approximately every 13 minutes across a day-long shift (18). During emergency bushfires, firefighters' heart rates have been shown to be above 70 per cent of their maximum for 15 per cent of their shift (or for nine minutes every hour) (18).



### Fire-Suppression Activities, Intensities and Durations – Key Findings

- The most 'critical' (that is, most frequent, important and physically demanding) tasks performed when fighting bushfire include advancing, lateral and full repositioning of a charged 38mm hose, together with using a manual tool during blacking out activities.
- These tasks are characterised by carry, drag, and dig actions and challenge firefighters' endurance and strength-endurance capabilities.
- Bushfire suppression duties are characterised by intermittent (from 20 to 180 seconds) period of intense work (greater than 70 per cent of maximal heart rate) periods separated by longer periods (65-80 per cent of a shift) of lower level labour and/or rest.

### Current Fitness Testing Methods

At present, most volunteer firefighters do not undertake fit-for-duty testing before they are deployed to the fireground (1). One exception is the Australian Capital Territory Rural Fire Service (ACT RFS), which has implemented two tests:

1. The Pack Hike Test (PHT) used to screen personnel prior to interstate deployments.
2. The Field Walk Test (FWT) used to screen personnel for their suitability to fight fires within the ACT.

Research was undertaken comparing the finishing times for the PHT and FWT tests in comparison with the completion times of key fire suppression duties to establish whether these tests accurately represented firefighters' work-rates during critical bushfire fighting tasks (19). Firefighter finishing times on the PHT and FWT were shown to be moderately (though statistically significantly)

correlated with the finishing time for the critical tasks (19). Generally, however, the two tests overestimate the work intensity of routine tanker-based bushfire fighting tasks (19). The overestimation of work intensity findings, coupled with the differences between the core movements and actions of the FWT and PHT (prolonged load carriage) compared with the movements and actions for tanker-based bushfire suppression (carry, drag, dig, rake (15)), suggest that the two tests may not adequately reflect the inherent challenges of fighting bushfires from fire tankers (19). Tanker-based agencies could consider devising and trialling fit for duty tests that are more representative of actual work demands than the PHT and the FWT.

### Heat Stress and Hydration

Heat stress has been shown to be one of the top three leading causes of injury during fire suppression (8). Bushfires most often occur in hot, dry weather and produce extreme radiant heat. Heat stress caused by the weather conditions and the fire is exacerbated by a firefighter's own exertion (20) and personal protective clothing (21). The combined heat load faced by rural firefighters increases their risk of developing heat exhaustion, which may render firefighters incapable of continuing their work (22). Heat exhaustion can be prevented or lessened by:

- Increasing cardiovascular fitness.
- Losing excess body fat.
- Acclimatising to work in warm to hot weather before the fire season (8).

Factors that may increase the risk of developing heat exhaustion during physical work include:

- Sunburn.
- Alcohol consumption.
- Recent illness.
- Dehydration (23).

Bushfire CRC research has shown that firefighters often arrive at a shift in a

### END USER STATEMENT

"As a result of the research that has been conducted to date through the Bushfire CRC, fire agencies are creating a sound scientific foundation for the development of future strategies to minimise the impact of fitness-related hazards facing our firefighters on the fire ground.

"We have known for many years that we needed to understand more about the impact of the physical work, heat, hydration, fatigue and fitness on our people. Already agencies are using the outcomes of the research to start educating our people and implementing wellness strategies to help them manage their own fitness and wellbeing."

– Robyn Pearce, Director Human Services, Tasmania Fire Service

dehydrated state and remain dehydrated throughout the day despite being aware of the physical tasks and duties that they will be required to perform (24). Dehydration can increase heart rate during physical work, which may increase firefighters' risk of cardiovascular strain during or after their shift (24). Such dehydration-mediated cardiovascular strain may be particularly hazardous for older, less-fit firefighters.

### Hydration Strategies

Based on sporting hydration guidelines (25), researchers have studied the impact on firefighter work and physiology of consuming 500 ml of water before bushfire fighting (26). It was found that additional fluids provided no additional benefit to the firefighters (26). Generally when fighting bushfires in mild weather (average temperature: 21°C), firefighters naturally consumed enough food and drink to complete their shift in a well-hydrated state (26). This finding suggests that fire agency food and fluid provisions are adequate for emergency firefighting operations in mild weather conditions. However, the impact of hydration prior to shift in emergency bushfire conditions could have vastly different results in hotter environmental temperatures and therefore requires further research.

Researchers have observed that urine and blood tests of hydration levels of firefighters often yield conflicting results (24, 26). Fire agencies should only cautiously rely solely on urine tests when determining hydration levels. More detail on research into hydration during bushfire suppression has been published in the related *Fire Note* number 81.

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