Acute effects of firefighting on arterial stiffness and blood flow

Christopher A Fahs¹,², Huimin Yan¹, Sushant Ranadive¹, Lindy M Rosso²,³, Stamatis Agiovlasitis¹, George Echols¹, Denise Smith³, Gavin P Horn⁴, Thomas Rowland⁵, Abbi Lane¹ and Bo Fernhall¹

Abstract
Sudden cardiac events are responsible for 40–50% of line-of-duty firefighter fatalities, yet the exact cause of these events is unknown. Likely, combinations of thermal, physical, and mental factors impair cardiovascular function and trigger such events. Therefore, the purpose of this study was to examine the impact of firefighting activities on vascular function. Sixty-nine young (28 ± 1 years) male firefighters underwent 3 hours of firefighting activities. Carotid, aortic, and brachial blood pressures (BP), heart rate (HR), augmentation index (Aix), wave reflection timing (TR), aortic pulse wave velocity (PWV), forearm blood flow (FFB), and forearm reactive hyperemia (RH) were measured before and after firefighting activities. Paired samples t-tests revealed significant (p < 0.05) increases in aortic diastolic BP, HR, Aix, PWV, RH, and FFB, and significant decreases in brachial and aortic pulse pressure and TR following firefighting activities. In conclusion, these results suggest that 3 hours of firefighting activities increase both arterial stiffness and vasodilation.

Keywords
arterial stiffness; blood flow; firefighting; vitamin C

Introduction
Sudden cardiac death is the leading cause of line-of-duty death among firefighters, accounting for 40–50% of fatalities each year.¹ The metabolic demands of live firefighting have been reported to range from 9.6 to 14 metabolic equivalents (METS)²³ with near maximal heart rates.⁴⁵ Environmental conditions involving live fire and high ambient temperatures⁶ coupled with strenuous activity in fully encapsulating firefighting personal protective equipment cause substantial elevations in core temperature following even short-term firefighting activity.⁴⁷ Intense physical exertion has independently been shown to trigger sudden cardiovascular events, particularly in those who are sedentary.⁸ It is thought that the combination of high levels of heat stress and physical exertion lead to sudden cardiac events in susceptible firefighters.⁹ Thus, sudden cardiac events in firefighters are usually attributable to ‘overexertion’ during fire suppression activities.¹

Several studies have documented increased cardiovascular risk factors in firefighters, including high levels of obesity.¹⁰–¹⁵ Cardiovascular risk factors have unfavorable impact on arterial function, including decreased endothelial function,¹⁶ and increased arterial stiffness,¹⁷ and central blood pressure (BP),¹⁸ all of which are predictive of all-cause cardiovascular mortality.¹³¹⁵ Furthermore, higher aortic stiffness is associated with increased risk for a cardiovascular event.¹⁰²¹ Changes in central BP, arterial stiffness, endothelial function and wave reflection after acute firefighting training may provide insight regarding the vascular stress encountered in this population. However, no study has

¹Department of Kinesiology and Community Health, University of Illinois, Urbana-Champaign, IL, USA
²Department of Health and Exercise Science, University of Oklahoma, Norman, OK, USA
³Department of Health and Exercise Sciences, Skidmore College, Saratoga Springs, NY, USA
⁴Illinois Fire Service Institute, Champaign, IL, USA
⁵Department of Pediatrics, Baystate Medical Center, Springfield, MA, USA

Corresponding author:
Bo Fernhall
Department of Kinesiology and Community Health
University of Illinois at Urbana-Champaign
227 Freer Hall MC-052
906 South Goodwin Avenue
Urbana, IL 61801
USA
Email: Fernhall@illinois.edu