Effect of exercise, heat stress and dehydration on myocardial performance

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Background
Myocardial dysfunction is a well-documented outcome of extended periods of high cardiac output. Whether similar effects occur during firefighting, an occupation characterized by repeated periods of work compounded by dehydration and heat stress, is uncertain.

Aims
To investigate the independent and combined effects of moderate heat stress and dehydration on indicators of myocardial performance following intermittent, submaximal treadmill exercise while wearing personal protective equipment (PPE).

Methods
Twelve aerobically fit young men (age 21.5 ± 2.6 years; maximal oxygen uptake [VO₂max] 60.3 ± 4.4 ml kg⁻¹ min⁻¹) performed intermittent treadmill walking exercise consisting of three 20 min bouts separated by two periods of rest in four different conditions in random order: (i) no heat stress-euhydrated, (ii) heat stress-euhydrated (heat stress created by wearing PPE), (iii) no heat stress-dehydrated and (iv) heat stress-dehydrated. We measured core temperature by a telemetric gastrointestinal pill. We determined cardiac variables by standard echocardiographic techniques immediately before and ~30 min after exercise.

Results
We recorded no significant changes in markers of systolic (ejection fraction, shortening fraction, tissue Doppler-S) or diastolic (mitral peak E velocity, tissue Doppler-E' and E/E’ function) function following exercise in any of the four conditions.

Conclusions
In this model of exercise designed to mimic the work, heat stress and dehydration associated with firefighting activities, we observed no negative effects on myocardial inotropic or lusitropic function.

Key words
Cardiac strain; diastolic function; firefighting; heat stress; systolic function.

Introduction
Experimental and observational studies have identified myocardial dysfunction as a consequence of prolonged periods of cardiac work. These reports describe depression of echocardiographic measures of both inotropic and lusitropic function in disparate conditions characterized by sustained levels of high cardiac output, including ultra-endurance athletic events [1], hyperthyroidism [2], pregnancy [3], obesity [4], anaemia [5] and arterial-venous malformations [6]. Myocardial dysfunction in some of these cases may be transient and reversible [7]; in others the disturbance of cardiac contractile and relaxation properties may be sufficiently severe as to manifest itself as congestive heart failure and contribute to disease morbidity and mortality [4].

Firefighting is an occupation characterized by repeated episodes of increased cardiac work, compounded by dehydration and augmented sympathetic-adrenal stimulation surrounding both heat and emotional stress [8]. These effects are compounded by the wearing of personal protective equipment (PPE), which increases the metabolic work demands on the cardiovascular system, augments thermal strain and accentuates dehydration via increased sweat loss [9,10]. Previous studies have documented the resultant tachycardia and diminished stroke volume during firefighting activity [11].

Fernhall et al. [12] studied echocardiographic measures of cardiac size and performance after repeated bouts of firefighting training exercises over a 3h period. After firefighting, a significant decline was observed in left ventricular...