

Cardiac Strain Associated with High-rise Firefighting

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Although numerous studies have reported the physiological strain associated with firefighting, cardiac responses during a large-scale fire operation have not been reported and cardiac responses have not been compared based on crew assignment. The aims of this study were (1) to characterize cardiac strain during simulated high-rise firefighting, and (2) to compare the cardiac strain associated with different work assignments (fire suppression vs. search and rescue) and different modes of vertical ascent (stairs vs. elevator). Firefighters ($N = 42$) completed one assignment (fire suppression, search and rescue, or material support) during one of two trials that differed by ascent mode. Assignments were divided into three phases: Ascent (ascend lobby to 8th floor), Staging (remain in holding area on 8th floor), and Work (perform primary responsibilities). When comparing assignments within the same ascent mode, mean heart rate (HR_{mean}) was higher ($p = 0.031$) for fire suppression than for search and rescue during Work in the stair trial (170 ± 14 vs. 155 ± 11 beats/min). Search and rescue crews experienced greater cumulative cardiac strain ($HR_{mean} \times \text{duration}$) during Work than did fire suppression crews (stairs: 1978 ± 366 vs. 1502 ± 190 beats; elevator: 1755 ± 514 vs. 856 ± 232 beats; $p < 0.05$). When comparing ascent mode, HR_{mean} and peak heart rate (HR_{peak}) were higher ($35\text{--}57$ beats/min; $p \leq 0.001$) for both fire suppression and search and rescue during Ascent and Staging phases in the stairs vs. the elevator trial. During Work, HR_{mean} was higher ($p = 0.046$) for search and rescue in the stairs vs. the elevator trial (155 ± 11 vs. 138 ± 19 beats/min). HR_{mean} and HR_{peak} were 47 and 34 beats/min higher ($p < 0.01$), respectively, when materials were transported to the staging area using the stairs compared with the elevator. Study findings suggest that high-rise firefighting results in considerable cardiac strain and that search and rescue and material support crews experienced more cardiac strain than fire suppression crews due primarily to differences in assignment duration. Furthermore, using stairs to transport firefighters and equipment to upper floors results in significantly greater cardiac strain than using the elevator.

Keywords cardiovascular strain, crew size, firefighter, heart rate, stairs

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INTRODUCTION

Firefighting is routinely recognized as strenuous and dangerous work. Multiple studies over the past several decades have used a variety of approaches to document the physiological demands of firefighting. Some studies have characterized energy requirements and cardiac strain of firefighting tasks performed in an ambient environment.^(1–3) Other studies have documented physiological responses to firefighting drills or simulated firefighting activities performed in a building with live fires^(4–9) or in the absence of fires.^(10–12) Finally, a few studies have documented firefighters' heart rate responses during actual emergencies.^(13,14) However, there are no published studies that investigated cardiac responses based on crew assignments (fire suppression, search and rescue, material support) that typically occur during high-rise firefighting operations.

During large-scale operations such as high-rise firefighting, engine companies are typically assigned to fire suppression, which includes advancing the hose line and extinguishing the fire, whereas truck companies are assigned to search and rescue, ventilation, and material support. The successful completion of the mission is often dependent on the coordinated activities of different crews. Furthermore, completion of a crew's assignment typically requires the coordinated performance of different activities by its members. To date there are no published articles that address the physiological burden associated with the typical primary assignments (such as suppression, search and rescue, material support) on the