

Effect of fatigue and protective clothing on functional balance of firefighters Pilwon Hur, Karl S. Rosengren, Gavin P. Horn, Denis Smith and and Elizabeth T. Hsiao-Wecksler

INTRODUCTION

- This study investigated the effect of wearing personal protective equipment (PPE) and different types of PPE on balance of firefighters (FFs).
- We also explored the effects of fatigue due to strenuous firefighting activities (FFAs) on balance of FFs.
- We developed a new functional balance test to measure functional balance of FFs.

METHODS

Subjects

- Sixty male FFs (ages 18-47) were divided into control (n=30) and intervention (n=30) groups.
- Standard PPE (control group) : typical PPE in US with helmet, heavily insulated hood, bunker gear, and rubber boots (Figure 1a).
- Enhanced PPE (intervention group) : designed with an industrial partner, included a light helmet, more breathable hood, bunker gear with reduced insulation, maximum breathability, and a passive cooling system, and lightweight leather-Kevlar boots (Figure 1b).

(b)



Figure 1. (a) Standard PPE (control group). (b) Enhanced PPE (intervention group)

Firefighting Activities

- To assess the effect of FFA on functional balance, subjects were evaluated at three testing periods:
- Baseline (BL) : initial, normal clothing. Pre-activity (PE) : before FFA Post-activity (PO) : after FFA

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Figure 2. Simulated FFAs. Forcible entry, hose advancement, stair climb, and room search from left to right.

Functional balance test



Figure 3. Functional balance test

- platform.

RESULTS

Raw time increased along with FFA. We found significant difference between BL and PE, and between PE and PO (Figure 4a, b). Thus, wearing PPE and conducting FFAs significantly increase raw time.

Enhanced PPE slightly reduced raw time. Enhanced PPE also reduced variability of raw time. The existence of bar slowed down the speed of movement.

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FFA consisted of 18 min of alternating work-rest cycles that included four simulated FFAs (Figure 2)



Subject began on a raised platform. Stepped down and walked on a narrow

plank with obstacle (set at 75% subject height) at the center of pathway.

Stepped up and turned around on a raised

Walked back to stop within a defined space. Subjects performed 8 trials: 2 trials with no bar, 4 with bar, and finally 2 trials with bar.



- careful after FFAs.
- variability significantly.

SUMMARY

- firefighter's movement.

References:

Major and minor errors increased significantly from BL to PE. However, these slightly decreased from PE to PO. FFs might be

Performance indices significantly increased from BL to PE and slightly decreased from PE to PO. The existence of bar significantly increased performance indices. It also increased

Wearing PPE and weight of PPE impairs balance. Firefighting activities significantly slows down the speed of

Firefighters are much more unstable when obstacle exists.

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