RELATIONSHIP BETWEEN MOVEMENT EFFICIENCY AND OXYGEN CONSUMPTION IN ACTIVE-DUTY FIREFIGHTERS

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INTRODUCTION

- There is growing research interest in maximizing and maintaining workability in firefighters, as firefighting requires near maximal levels of exertion and oxygen consumption.[6]
- As a result of the demands of the job, firefighters are consistently at risk of injury. In 2021, there were an estimated 60,750 firefighter line of duty injuries.[1]
- 19,200 injuries occurred on the fireground in 2021. Overexertion and strain accounted for 25% of all fireground injuries. Falls, jumps, slips, and trips accounted for 24% of all fireground injuries.[1]
- There were 41,250 non-fireground injuries in 2021. The most prevalent nature of injury for non-fireground injuries was strain, sprain, or muscular pain, which accounted for 58% of injuries in training exercises and 52% of injuries in non-fire emergencies.[1]
- These data would indicate that neuromuscular injury is of high prevalence in firefighters, and improving qualities of physical performance may be beneficial to firefighter injury prevention and reducing time lost due to injury.
- It has been previously indicated that higher aerobic capacity and muscular strength and endurance are linked to greater performance on simulated firefighting tasks.[5]
- Additionally, movement efficiency (ME) and balance have been linked to muscular strength in firefighter recruits.[2]
- However, the relationship between ME and aerobic capacity in active-duty firefighters is currently unknown.
- Understanding this relationship may help practitioners working with the firefighter population to improve overall fitness to meet job demands across cardiorespiratory and neuromuscular domains, thus improving firefighter performance.
- This relationship may also expand the understanding of physical fitness factors that may be important to firefighter work capacity.

PURPOSE

- The ***purpose*** of this study was to investigate the relationship between movement efficiency and oxygen consumption in submaximal and maximal aerobic capacity protocols.

METHODS

Participants

- 10 (8 male, 2 female) active-duty firefighters (34.6 ± 8.99 yrs; 1.77 ± 0.06 m; 83.74 ± 12.99 kg) participated in this study.

Procedures

- Participants completed a battery of anthropometric assessments, including height (m), body weight (BW; kg), body mass index (BMI; kg/m^2), and body fat % (BF%).
- Participants completed a Fusionetics™ Movement Efficiency Screen (MES), a submaximal Forestry Step Test (FST).
- On a separate day, participants completed a maximal treadmill (TM) test.
- The maximal TM test followed the protocol outlined by the International Association of Firefighters and International Association of Fire Chiefs Wellness-Fitness Initiative (WFI). While the protocol is outlined as a submaximal test that terminates when participants reach 85% of maximal heart rate, each participant continued until reaching maximal exertion.
- Heart Rate (HR) was monitored continuously during each test and used post-hoc to estimate peak oxygen consumption (VO_2) for the FST ($VO_{2PEAK\text{-}FST}$).
- VO_2 was measured via direct gas analysis during each test to identify peak values for the FST (VO_{2FST}) and TM test ($VO_{2PEAK\text{-}TM}$).

Statistical Analyses.

- Bivariate Pearson correlations were calculated to identify relationships between MES and $VO_{2PEAK\text{-}TM}$, $VO_{2PEAK\text{-}FST}$, VO_{2FST}, as well as the total TM test time (min).
- Statistical significance was determined with an alpha of $p < 0.05$.

RESULTS

- Descriptive statistics are displayed in Table 1.
- Results of the correlation analysis are displayed in Table 2.

Table 1.

	Mean ± SD	Range
MES score	66.99 ± 8.48	55.05 - 82.73
VO_{2FST} (mL/kg/min)	27.64 ± 2.03	24.70 - 30.00
$VO_{2PEAK\text{-}FST}$ (mL/kg/min)	45.43 ± 6.44	35.58 - 56.95
$VO_{2PEAK\text{-}TM}$ (mL/kg/min)	44.31 ± 4.46	35.90 - 49.30
TM test time (min)	12.08 ± 1.39	8.68 - 13.63

RESULTS (continued)

Table 2.

	MES score
VO_{2FST} (mL/kg/min)	-0.789**
$VO_{2PEAK\text{-}FST}$ (mL/kg/min)	-0.155
$VO_{2PEAK\text{-}TM}$ (ml/kg/min)	-0.059
TM test time (min)	0.353
*** = $p < 0.05$, ** = $p < 0.01$**	

CONCLUSIONS

- Lower MES score was related to higher oxygen cost in submaximal stepping but not related to oxygen consumption in a maximal effort treadmill test.
- There was a moderate, non-significant relationship between MES score and TM test time, suggesting that ME may impact treadmill time.

PRACTICAL APPLICATIONS

- Improvement of movement efficiency may be an important factor to firefighter injury prevention. It has been previously indicated that corrective exercise programming may be useful to improve movement efficiency in firefighters.[4]
- Improvement of movement efficiency may decrease the oxygen cost of a submaximal stepping task.
- Since stepping is a significant component to firefighter job tasks, improving movement efficiency may decrease overall internal workload experienced by a firefighter.
- Future researchers should seek to examine changes in oxygen consumption in submaximal stepping tasks as a result of improvements in movement efficiency.

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