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The impact of occupational tasks on firefighter hydration during a live structural fire

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Introduction

• Firefighters are exposed to a multitude of physical and environmental stresses during their normal duties (Cuddy et al. 2015)
  • Intense bouts of physical activity (Holsworth et al. 2013)
  • Environmental extremes (Horn et al., 2012)
  • Impermeable, heavy and restrictive Personal Protective Equipment (PPE) (Horn et al., 2012)

• Without adequate fluid intake firefighters may experience the adverse effects of dehydration (Raines et al. 2015)
Introduction

• Evidence investigating firefighter hydration during structural fire suppression is both limited and conflicting

• Current evidence is unclear whether ad libitum drinking is sufficient to maintain hydration
  • Angerer et al., 2008
  • Eglin et al., 2004
  • Holsworth et al., 2013
  • Horn et al., 2012
  • Smith et al., 2001

• More evidence aids the development and refinement of firefighter hydration protocols and health and safety guidelines
Aim

To investigate the impact of performing occupational tasks during an active structural fire on firefighters’ hydration status.
Methods

• Prospective observational cohort study
• 9 firefighters from a Queensland State Fire and Emergency Service volunteered to participate in a 15 minute ‘live’ structural firefighting scenario involving 2 occupational tasks
  • Victim drag
  • Hose drag

• Ethics approved by Bond University HREC, Protocol Number RO1761
Methods

• Outcome measures:
  • Body weight (BW) and urine specific gravity (USG)
  • Tympanic membrane

• Conducted pre-scenario, 0 minutes post and 20 minutes post

• Analysis
  • Statistical significance determined via an ANOVA analysis
  • Results compared against National Athletic Trainers’ Association dehydration guidelines (Casa et al., 2000)
## Results - Participants

Table 1: Descriptive characteristics of firefighter participants

<table>
<thead>
<tr>
<th></th>
<th>MEAN ± SD</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>39.22 ± 7.89</td>
<td>29 – 48</td>
</tr>
<tr>
<td>Experience (yrs)</td>
<td>7.89 ± 5.18</td>
<td>1 – 16</td>
</tr>
<tr>
<td>Unloaded weight (kg)</td>
<td>90.41 ± 21.35</td>
<td>62.40 – 126.6</td>
</tr>
<tr>
<td>Loaded body weight (kg)</td>
<td>111.80 ± 21.89</td>
<td>82.7 – 149.0</td>
</tr>
</tbody>
</table>
Results - Scenario

- Fire temperatures
  - 40.0 °C (max 50.9 °C) at 0.3m above the floor
  - 130-155 °C at 1.1m above the floor
  - 458.3 °C (max 571.5 °C) at the ceiling
- The relative humidity was 53.1-58.6%.
# Results - Hydration

Table 2: Mean data ± SD and ranges for the pre-scenario and post-scenario measures.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>20 MIN POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine Specific Gravity</td>
<td>1.016 ± 0.010</td>
<td>1.018 ± 0.010</td>
<td>1.018 ± 0.009</td>
</tr>
<tr>
<td>Unloaded Body Mass (kg)</td>
<td>95.57 ± 21.52</td>
<td>94.84 ± 21.35*</td>
<td>94.37 ± 21.35##</td>
</tr>
<tr>
<td>Tympanic Membrane</td>
<td>36.53 ± 0.35</td>
<td>38.94 ± 0.42*</td>
<td>37.76 ± 0.45##</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant change (p<0.05) from pre-scenario

# Significant change (p<0.05) from post-scenario
Discussion

• BW results similar to other studies (Angerer et al., 2008; Eglin et al., 2004; Horn et al., 2012)

• Although statistically significant at 0 minutes it did not reflect a change in hydration status (Casa et al., 2000)

• Minimal shift towards rehydration at 20 minutes post
  • Highlights that fluid loss can occur rapidly and dehydration may result without fluid replacement
Discussion

• Firefighters arrived on shift in a minimally dehydrated state

• Given the significant decrease in BW it is of interest to find no significant changes in USG
  • Poor correlation between body weight and change in USG (Horn et al. 2004)

• Potential lag in USG during periods of rapid body fluid turnover due to the protective role of the kidneys (Popowski et al., 2001)
Discussion

• Significant increase in firefighter tympanic membrane temperature
  • Remain elevated for at least 20 minutes

• Mean increase of 2.4°C is substantially higher than seen in previous studies (Smith et al., 2001; Angerer et al., 2008; Carlton et al., accepted)

• Extensive evidence on the high thermal demands of firefighting
  • Post-activity cooling strategies paramount
Implications

• Short duration firefighting operations can cause significant fluid loss with the potential to lead to dehydration
  • may be exacerbated by arriving on shift in dehydrated state

• Further research to determine fluid replacement requirements is warranted
Article
The Impact of Occupational Tasks on Firefighter Hydration During a Live Structural Fire

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References


References


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