Monitoring (physical) stress in professional fire fighters

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Content

• Background
• Zephyr Bioharness
• Acute stress (controlled setting)
• (Physical) stress during 24 hours shifts
• General conclusion and discussion
Background

- Extreme situations
• Zephyr Bioharness
  – Heart rate
  – Breathing rate
  – Heart rate variability
  – Accelerometer
  – GPS
- Heart rate is valid at different intensity levels (Kim et al, 2012; own research)
  - At rest validity least confirmed
- Respiratory rate also valid at different intensity levels (Kim et al, 2012; Hailstone and Kilding 2011; own research)
  - could be underestimation
Acute stress (controlled setting)
1. Determining if a change in heart rate, breathing rate or heart rate variability, measured with Zephyr Bioharness, can be an indication of acute stress.

2. Determining if a combination in these variables is associated with acute stress.
Methods

- Participants:
  - 10 professional fire fighters
  - Mean age 39 years (SD 7.3)

VAS
0 = No stress 10 = Maximal stress

Rest: 5 min  DT test: 6 min  Rest: 5 min
Results

-20  0  20  40  60  80  100  120

heart rate breathing rate HRV VAS

-20

<table>
<thead>
<tr>
<th></th>
<th>rust 1</th>
<th>oefening</th>
<th>test</th>
<th>rust 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>heart rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>breathing rate</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HRV</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>VAS</td>
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</tbody>
</table>

* indicates significant difference.
• Increase in breathing frequency and decrease in HRV can be indicators of acute stress
• Combination of both seem to be associated with stress

• However,
  – Is there (enough) stress evoked?
  – No correlation between VAS and physiological parameters.
(Physical) stress during 24 hours shifts
To determine the (physical) stress during 24 hours shifts in professional fire fighters using Zephyr Bioharness.
## Methods

- 18 professional fire fighters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number</th>
<th>Mean (Min-max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male/female)</td>
<td>16/2</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td>38.8 (25 – 49)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td>25.8 (21 - 30.6)</td>
</tr>
<tr>
<td>Experience (years)</td>
<td></td>
<td>12 (5 – 24)</td>
</tr>
<tr>
<td>Smoking (yes/no)</td>
<td></td>
<td>7/11</td>
</tr>
<tr>
<td>Sport participation (yes/no)</td>
<td></td>
<td>10/8</td>
</tr>
</tbody>
</table>
Methods

• During four 24 hour shifts (19, 26 April, 1 and 7 May 2013)
  – Wearing Zephyr Bioharness during all activities (except showering)
  – Subjects were instructed to do what they normally would do
Results

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:04</td>
<td>Before alarm</td>
</tr>
<tr>
<td>13:08</td>
<td>Alarm - Pullout</td>
</tr>
<tr>
<td>13:10</td>
<td>Pullout - on the spot</td>
</tr>
<tr>
<td>13:12</td>
<td>On the spot - retreat</td>
</tr>
<tr>
<td>13:14</td>
<td>Retreat - back</td>
</tr>
</tbody>
</table>

Heartrate/min
Results

Breathing rate/min

Before alarm
Alarm – Pullout
Pullout – on the spot
On the spot – retreat
Retreat – back

Time

Results

<table>
<thead>
<tr>
<th>HRV (ms)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>13:04</td>
</tr>
<tr>
<td>180</td>
<td>13:06</td>
</tr>
<tr>
<td>160</td>
<td>13:08</td>
</tr>
<tr>
<td>140</td>
<td>13:10</td>
</tr>
<tr>
<td>120</td>
<td>13:12</td>
</tr>
<tr>
<td>100</td>
<td>13:14</td>
</tr>
<tr>
<td>80</td>
<td>13:16</td>
</tr>
<tr>
<td>60</td>
<td>13:18</td>
</tr>
<tr>
<td>40</td>
<td>13:20</td>
</tr>
<tr>
<td>20</td>
<td>13:22</td>
</tr>
<tr>
<td>0</td>
<td>13:24</td>
</tr>
</tbody>
</table>

- **Before alarm**
- **Alarm – Pullout**
- **Pullout – on the spot**
- **On the spot – retreat**
- **Retreat – back**
Results

- Heart rate (ms)
- Breathing rate (min)
- HRV (ms)

- before alarm
- alarm - pullout
- pullout - on the spot
- on the spot - retreat
- retreat - back
• Information about physical stress during actions
  – Difference between persons
  – Duration of high intensity exercise
• Stress hard to measure in practice
• Information about the physical stress can, ultimately, be used to train as specific as possible
General conclusion and discussion

- In a controlled environment a combination of a increase in breathing rate and a decrease in HRV might be associated with stress
  - However, stress in practice X
- The Zephyr Bioharness can be used during 24 hour shifts to get more insight in the physical stress during these shifts and especially the actions
Billy – Gene Holder, 77 year old fire fighter worked for 56 years for the fire department in Irving
Questions?