Monitoring changes in physical performance with heart rate measures in young soccer players

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Optimizing training process

Monitoring
✓ Training load
✓ Fatigue/recovery
✓ Adaptation to training
  - Performance
  - Physiology

Managing / adjusting
✓ Training load and contents
Optimizing training process

Tools in (youth) football:
✓ Practical (field)
✓ Objective
✓ Reliable
✓ Non-invasive
✓ Non-fatiguing
✓ Time-efficient
HR measures: the solution?

- **HR during (submax) exercise (HReX):**
  - Cardiorespiratory fitness
  - Changes related to changes in (endurance) performance \((Andrew\ JAP\ 1966)\)
  - Fatigue? \((Coutts\ JSMS\ 2007;\ Bosquet\ BJSM\ 2009)\)
  - Marker of performance decrement? \((Brink\ SJMSS\ 2010,\ Schmikli\ BJSM\ 2010)\)

- **HR recovery (HRR):**
  - Respond to training loads / volume \((Borresen\ EJAP\ 2007,\ Buchheit\ AmJP\ 2006)\)
  - Changes related to changes in running performance (both endurance and repeated-sprint ability) \((Buchheit\ MSSE\ 2008,\ EJAP\ 2010a)\)

- **HR variability (HRV):**
  - Cardiorespiratory fitness \((Buchheit\ AmJP\ 2006)\)
  - Changes related to changes in running performance (both endurance and repeated-sprint ability) \((Buchheit\ MSSE\ 2008,\ EJAP\ 2010a)\)
  - Level of homeostasis disturbance ➔ acute impact of exercise \((Al\ Haddad\ IJSSPP\ 2009)\)
  - Overall training adaptation / recovery (increases when tapering) \((Pichot\ MSSE\ 2002)\)
  - Psychological stress \((Pichot\ Pflugers\ Acrch\ 2002)\)
Purpose

To verify the validity of using:

✓ Submaximal HReX
✓ HRR
✓ post-exercise HRV

to predict changes in physical performance over an entire competitive season in highly-trained young soccer players.
Methods

• 92 young soccer players (age 15.1 +/- 1.5 y)
• 14 hours of combined soccer-specific training and competitive play per week
• Tested 3 times per year (i.e., October, January and May)
  • Performance field tests
  • HReX/HRR/HRV measures (i.e., 5’-5’ test)
Performance tests

- Anthropometry / Peak Height Velocity (PHV)
- Counter movement jump (CMJ)
- 40-m sprint with 10-m split times
  - Acceleration (1st 10 m) / MSS (best split)
- Repeated-sprint ability (RS)
- Incremental track test ($V_{\text{Vam-eval}}$)
Submaximal running test: 5’-5’
5’-5’ test: all in one!

- HRR (60 s)
- HRex (30 s)
- HRV (3 min)
- Ln rMSSD (vagal-activity)

- 5’ @ 9 km/h
- 5’ seated recovery

Data analysis

No overload = stable data

CV:
✓ 3 % for HReX
✓ 13% for HRR
✓ 10% for HRV

Buchheit EJAP 2010b
Data analysis

- 65 complete data sets available (46 players)
  - October to January and/or
  - January to May

  - Changes in performances
    - Adjusted for changes in body mass
    - Expressed as Cohen’s d

Substantial (>CV) decrease in HRe
or increase in HRR
or increase in HRV

Changes in physical performance?

No change in HRe x, HRR or HRV

Substantial (>CV) increase in HRe
increase in HRR or decrease in HRR
or decrease in HRV

Changes in physical performance?
Results

Adjusted for changes in body mass

Buchheit et al. Ejap 2011
Results

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Buchheit et al. Ejap 2011

[Graph showing the relationship between individual change in $V_{\text{Em-Eval}}$ (%) and individual change in $H_{\text{Reax}}$ (%$H_{\text{Rmax}}$) with regression lines for Pre-PHV ($r = 0.73$ (0.49;0.87)), Circum-PHV ($r = 0.65$ (0.34;0.8)), Post-PHV ($r = 0.46$ (0.14;0.69)), and All pooled ($r = 0.63$ (0.48;0.74)).]
Results

Adjusted for changes in body mass

Buchheit et al. Ejap 2011
Results

Adjusted for changes in body mass

Buchheit et al. Ejap 2011
### Results

Controlled for changes in body mass

<table>
<thead>
<tr>
<th>Baseline values ($n$ pairs of data = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HReX</strong></td>
</tr>
<tr>
<td>$V_{Vam-Eval}$ 0.47 (0.17; 0.69)</td>
</tr>
<tr>
<td><strong>HRR</strong></td>
</tr>
<tr>
<td>Unclear</td>
</tr>
<tr>
<td><strong>Ln rMSSD</strong></td>
</tr>
<tr>
<td>Unclear</td>
</tr>
</tbody>
</table>

| **CMJ**                                |
| Unclear                                |
| **Acc**                                |
| Unclear                                |
| **MSS**                                |
| Unclear 0.39 (0.07; 0.64)              |
| **RS**                                 |
| Unclear $-0.38$ $(-0.05; -0.64)$       |

Changes in physical performance variables over a season

*Buchheit et al. Ejap 2011*
Conclusions

• Monitoring HReX and HRV is effective in tracking improvements in $V_{Vam-Eval}$

• The use of HReX, HRR and HRV as systematic markers of physical performance decrements in youth soccer players ([Brink SJMSS 2010, Schmikli BJSM 2010]) is questioned
Applications

- Monitoring changes in performance
- Assess training effectiveness
- Trainability?
- Acute/chronic fatigue?
- Readiness to perform?

→ Adjust training contents
→ Adapt playing strategies

When?
✓ Start of the season
✓ Before/after each training cycle
✓ When needed on an individual basis