Modelling the load-injury relationship

Latest evidence and future directions

Presented by Dr. Sean Williams
Theoretical basis for monitoring loads

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Current best practice?

**Acute:Chronic Workload Ratio [ACWR]**

**Acute** | Recent loads (e.g. one week), analogous to state of ‘fatigue’

**Chronic** | Average loads over last 3-6 weeks, analogous to state of ‘fitness’

![Load vs Week Graph]

**Acute:Chronic**

\[
\frac{200}{125} = 1.60
\]
Acute:Chronic Workload Ratio

Acute:Chronic Workload Ratio

Calculating acute:chronic workload ratios using exponentially weighted moving averages provides a more sensitive indicator of injury likelihood than rolling averages

Nicholas B Murray,¹ Tim J Gabbett,² Andrew D Townshend,¹ Peter Blanch³,⁴
Smoothed averages

MODELLING THE LOAD-INJURY RELATIONSHIP

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Acute:Chronic Workload

Load [AU]

EWMA ACWR
Rolling ACWR

1.52
1.03
ACWR and injury prediction

Sensitivity 20%

Specificity 85%

Individual effects

- Using **mixed models**, it’s possible to get **unique effects for each athlete**:

  ![Graph showing individual effects and predicted probability of injury](image)

Aerobic fitness

ACWR > 1.50


Moderators in workload–injury investigations


Table 3: The injury likelihood using the equation derived from studies on three different sports (figure 2) comparing different scenarios of acute and chronic workload.

<table>
<thead>
<tr>
<th>Chronic workload (% of normal average)</th>
<th>Acute workload (% of normal average)</th>
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</thead>
<tbody>
<tr>
<td>110</td>
<td>60</td>
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<tr>
<td>100</td>
<td>70</td>
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<td>60</td>
<td>110</td>
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<tr>
<td>50</td>
<td>120</td>
</tr>
</tbody>
</table>

HRV as a stress/recovery marker

\[ p(t) = k_1 g(t) e^{-t/\tau_1} - k_2 h(t) e^{-t/\tau_2} \]

- \( p(t) \) = Performance
- \( g(t) \) = Fitness
- \( h(t) \) = Fatigue
- \( k_1, k_2 \) = Multipliers
- \( \tau_1, \tau_2 \) = Time constants
- \( t \) = Time
Planning optimal workloads

**AIM:**
Maximise total load, whilst keeping ACWR within safe zone

https://progressiveathleticperformance.com/

Future Directions

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Additional issues with ACWR?

Mathematical coupling causes spurious correlation within the conventional acute-to-chronic workload ratio calculations

Lorenzo Lolli,¹ Alan M Batterham,¹ Richard Hawkins,² David M Kelly,²,³ Anthony J Strudwick,² Robin Thorpe,²,³ Warren Gregson,³ Greg Atkinson¹
Conclusions

- Current best practice: High chronic loads are required to optimally prepare athletes for competition demands, but these must be achieved gradually and rapid ‘spikes’ in workloads should be avoided.
- Calculating the ACWR using EWMA may be more sensitive to injury risk than rolling averages.
- Our understanding of the moderators of this workload injury relationship is developing.
- Optimisation techniques may be used to create objective training plan designs that satisfy injury risk constraints.
- Technology, analysis and the integration of different forms of load are areas for future direction.