*Jarek Mäestu, PhD*

# Monitoring athlete´s training loads

Sports Injury Preventation Conference,

*27 February 2016*

*Tartu*

# Just some thoughts….

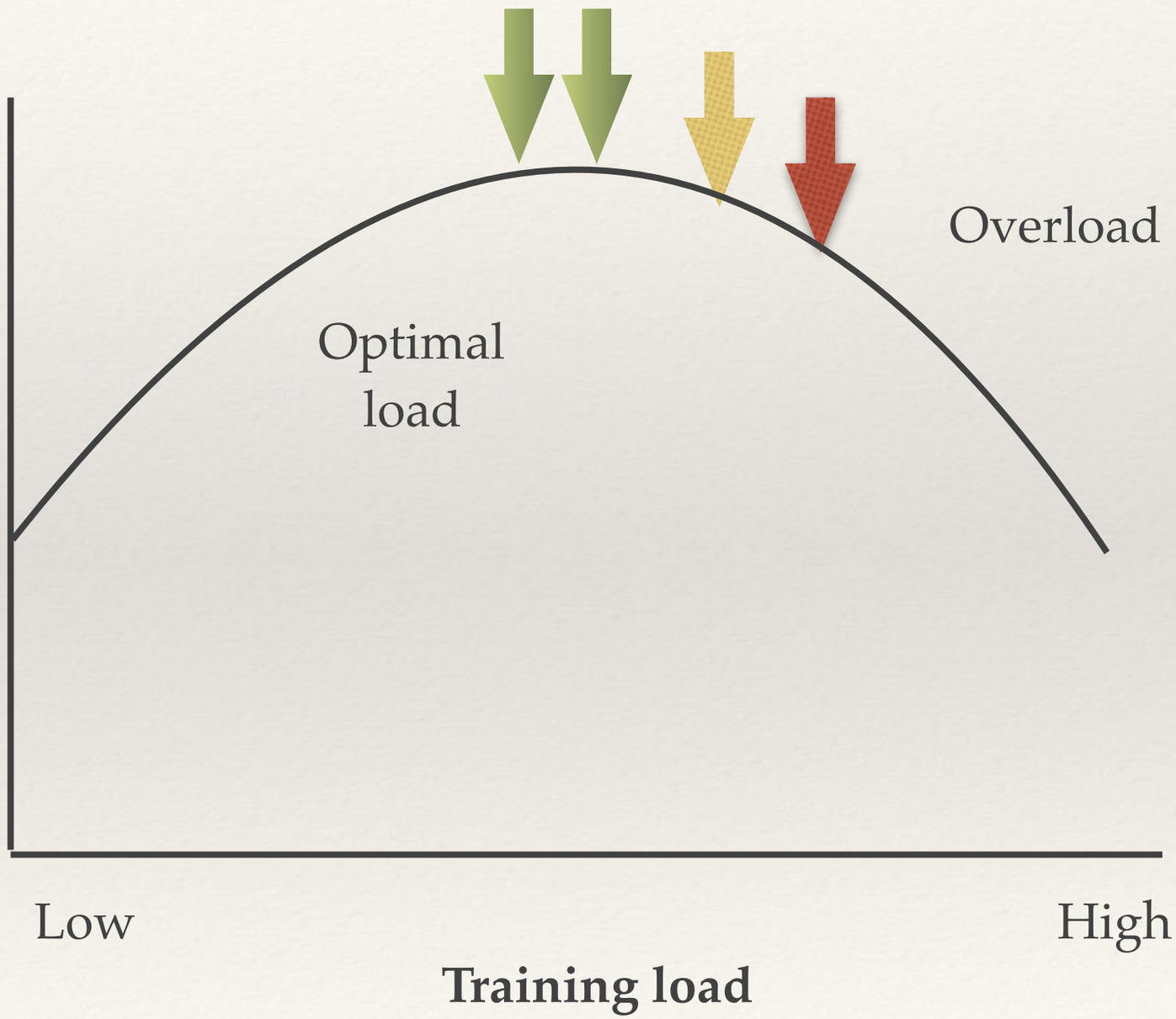
- Is physiotherapist the “bad” wanting to keep the athlete from training.
- How can we help coaches to max performance with minimizing the risk?
- Why the team rather measures external loads compared to internal load?
- Are the injuries preventable?

There is no theory that would describe the type, amount and intensity of different training methodology to compile an individualized training program for everyone.

- Empirical evidence
- Consensus ?
  - Higher workload - higher performance.

# Training load

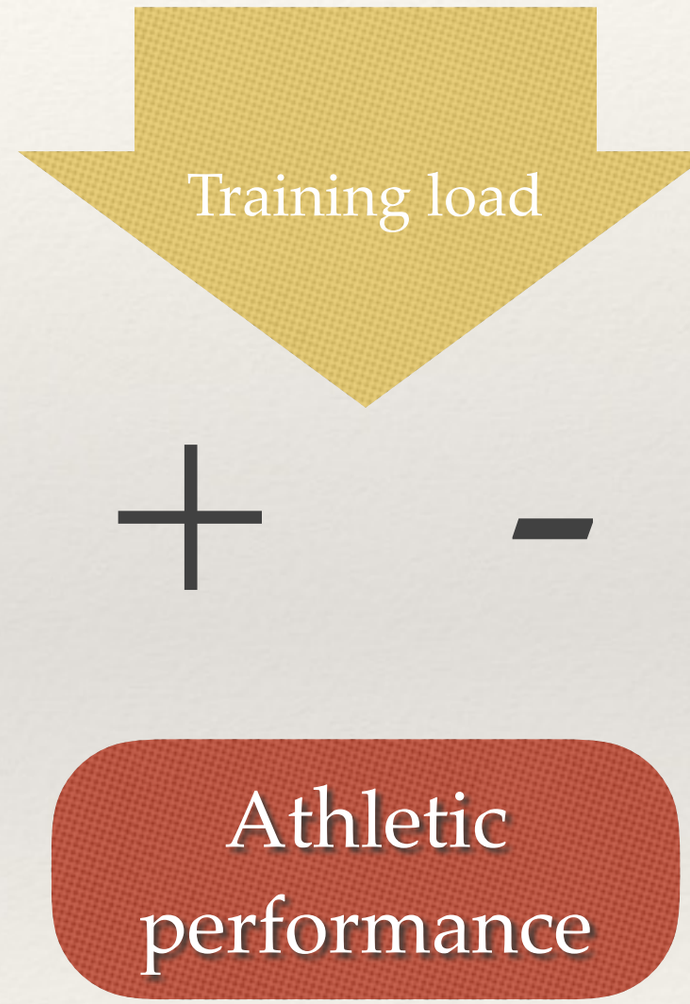
- **Volume X intensity**
  - Useless
  - Recovery
  - Improving
  - Overloading



# Training monitoring

The set of different tools or methods to increase the likelyhood of the positive outcome of athletic performance

- Why?
- What?
- How often?
- How?




Minimal testing - maximal reliable feedback

**Feeling of involvement**

# How big should be the change?

Is it also meaningful???

- For individual athlete: half of the variability of competitive performance, or 0.5-1 % in terms of power.
- One standard deviation difference from the average
- For team performance 1/5 of the standard deviation for average result of the team.

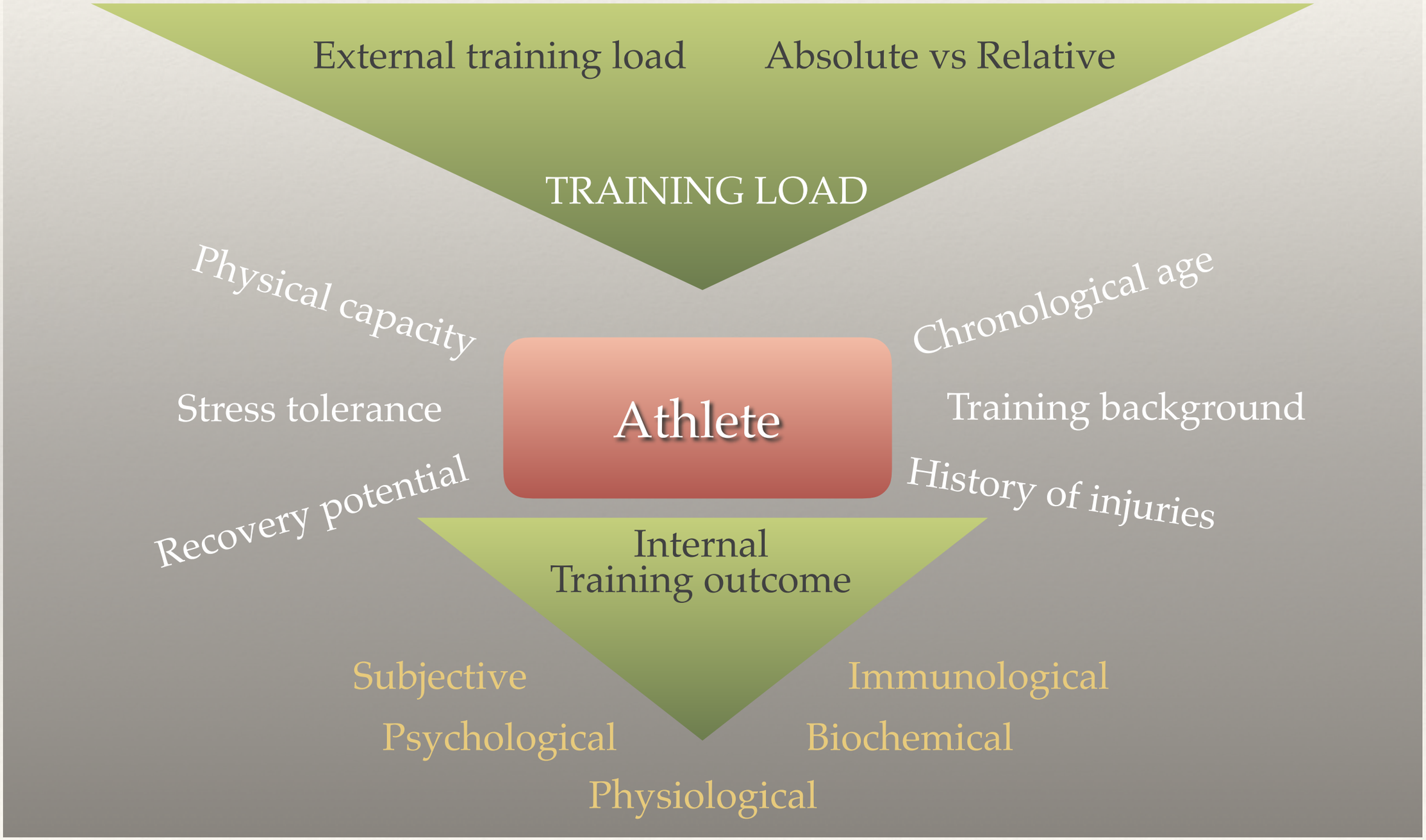
- Run up to 1500m 0,8%
- Run 1500 - 10000 1,1%
- Marathon 3,0%
- High jump 1,7%
- Mountain bike 2,4%
- Swimming 0,8%

(Hopkins, 2004)

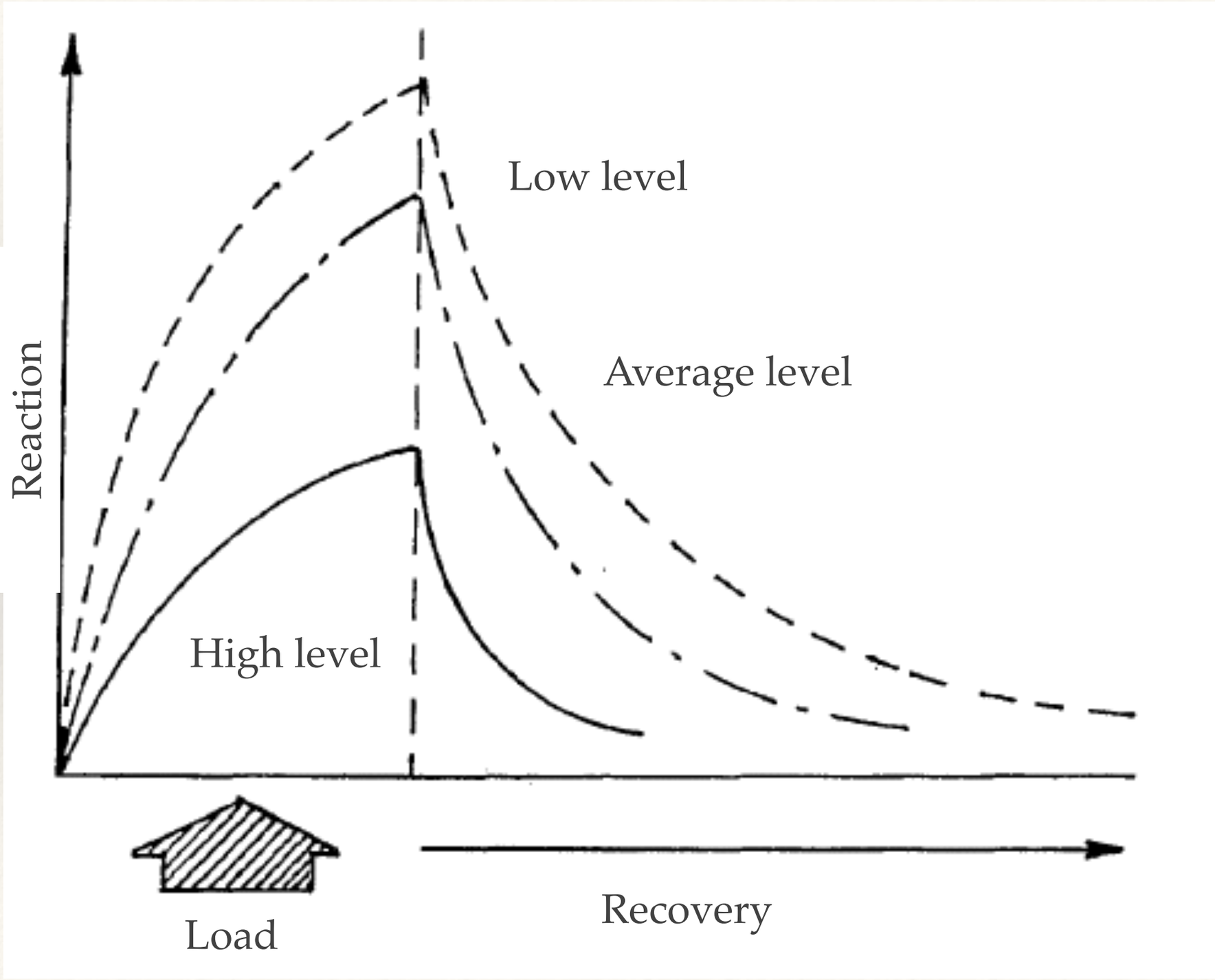
# What can we measure in terms of training load?

- EXTERNAL TRAINING LOAD
  - **Physical work**
    - Lifted weight
    - Covered distance
    - Number of jumps, throws
    - Intensity of the exercise
    - ……
- INTERNAL TRAINING LOAD
  - **Physiological response**
    - Heart rate
    - Perceived exertion
    - Psychological response
    - Hormonal/biochemical response
    - ……

# Training load response



# Internal load



# What is monitored?

Australian and New Zealand high performance athletes
Overall 91% coaches indicated some kind of monitoring

| What? | | How? | |
|---|---|---|---|
| Injury prevention | 29% | Self-reporting tests | 84% |
| Effectivness of training program | 27% | Performance test | 61% |
| Maintaining performance | 22% | Performance during competition | 43% |
| Preventing overtraining | 22% | Biochemical parameters | 8% |

Taylor, 2012

# Continuous overview

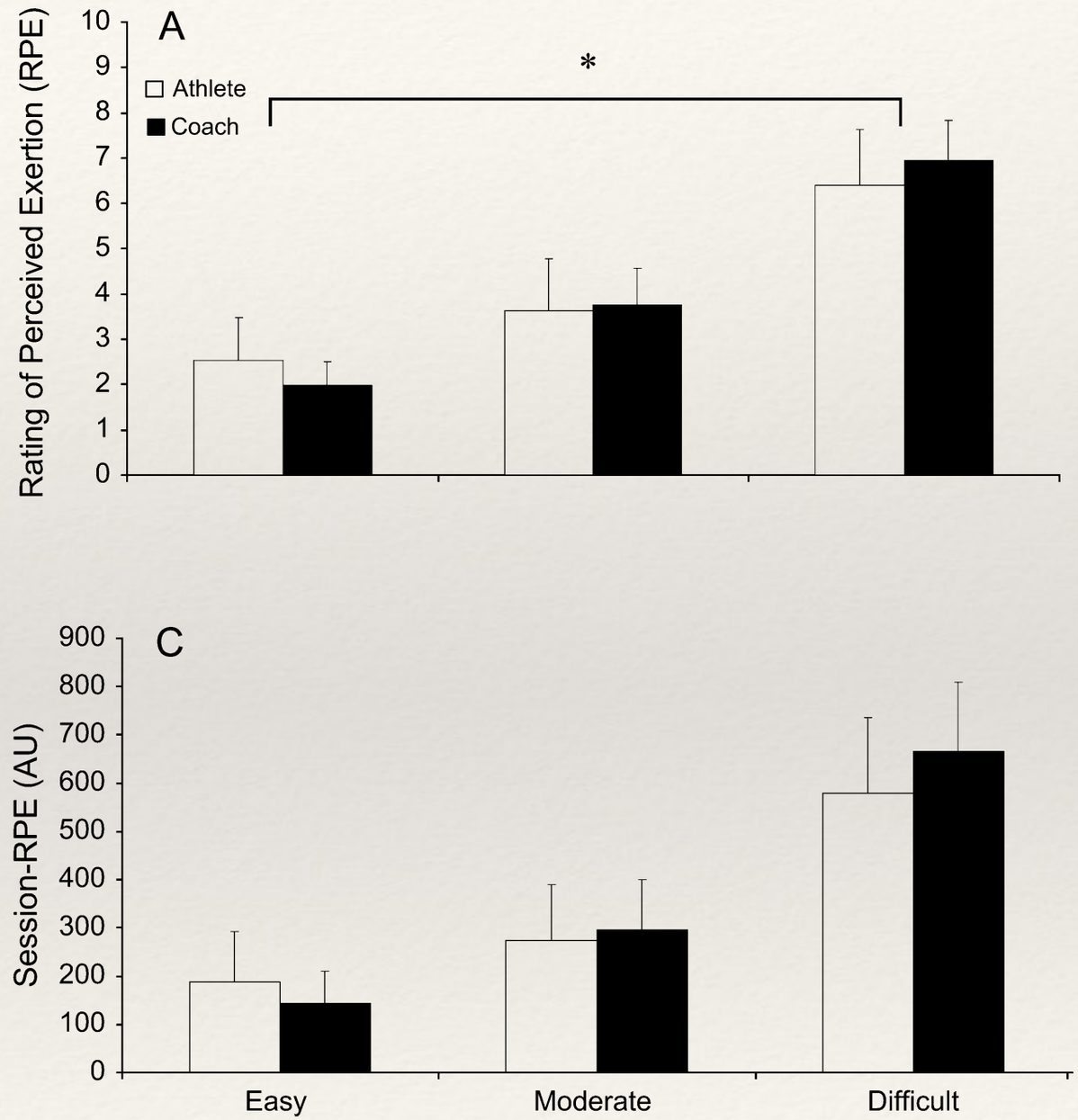
# Internal training load. Borg scale

- "How was your workout?"
- RPE x duration of the session
- In soccer:
  - 300-500 AU easy session
  - 700-1000 AU hard session
- In endurance:
  - 200-400 AU easy session
  - 600-900 AU hard session

| 1 - 10 Borg Rating of Perceived Exertion Scale | |
|---|---|
| 0 | Rest |
| 1 | Really Easy |
| 2 | Easy |
| 3 | Moderate |
| 4 | Sort of Hard |
| 5 | Hard |
| 6 | |
| 7 | Really Hard |
| 8 | |
| 9 | Really, Really, Hard |
| 10 | Maximal: Just like my hardest race |

# Session RPE at different intensities

- 12 competitive swimmers
- 20 training sessions at different intensities



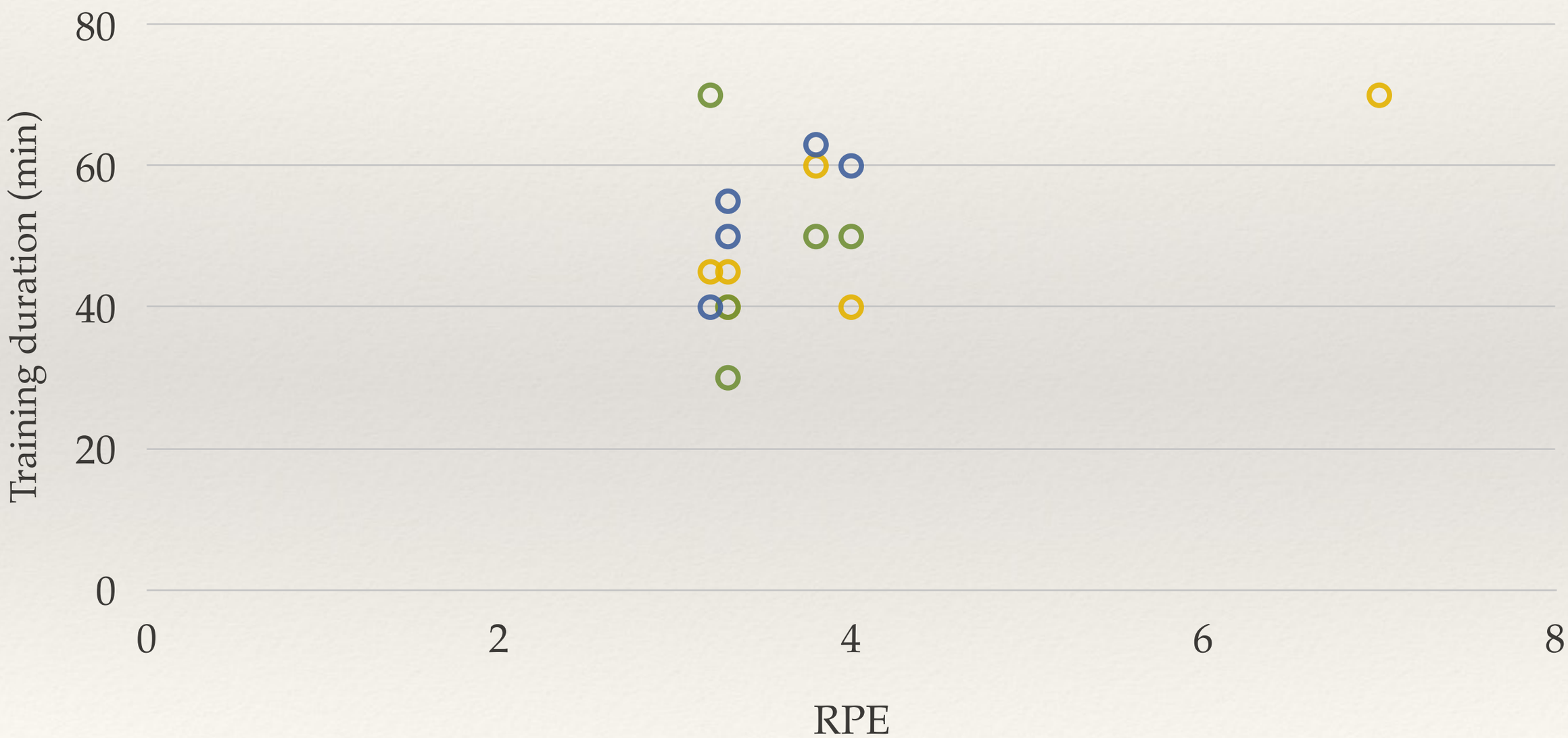

Wallace et al, 2008

# Session RPE
# Comparison between perception of coach and athlete

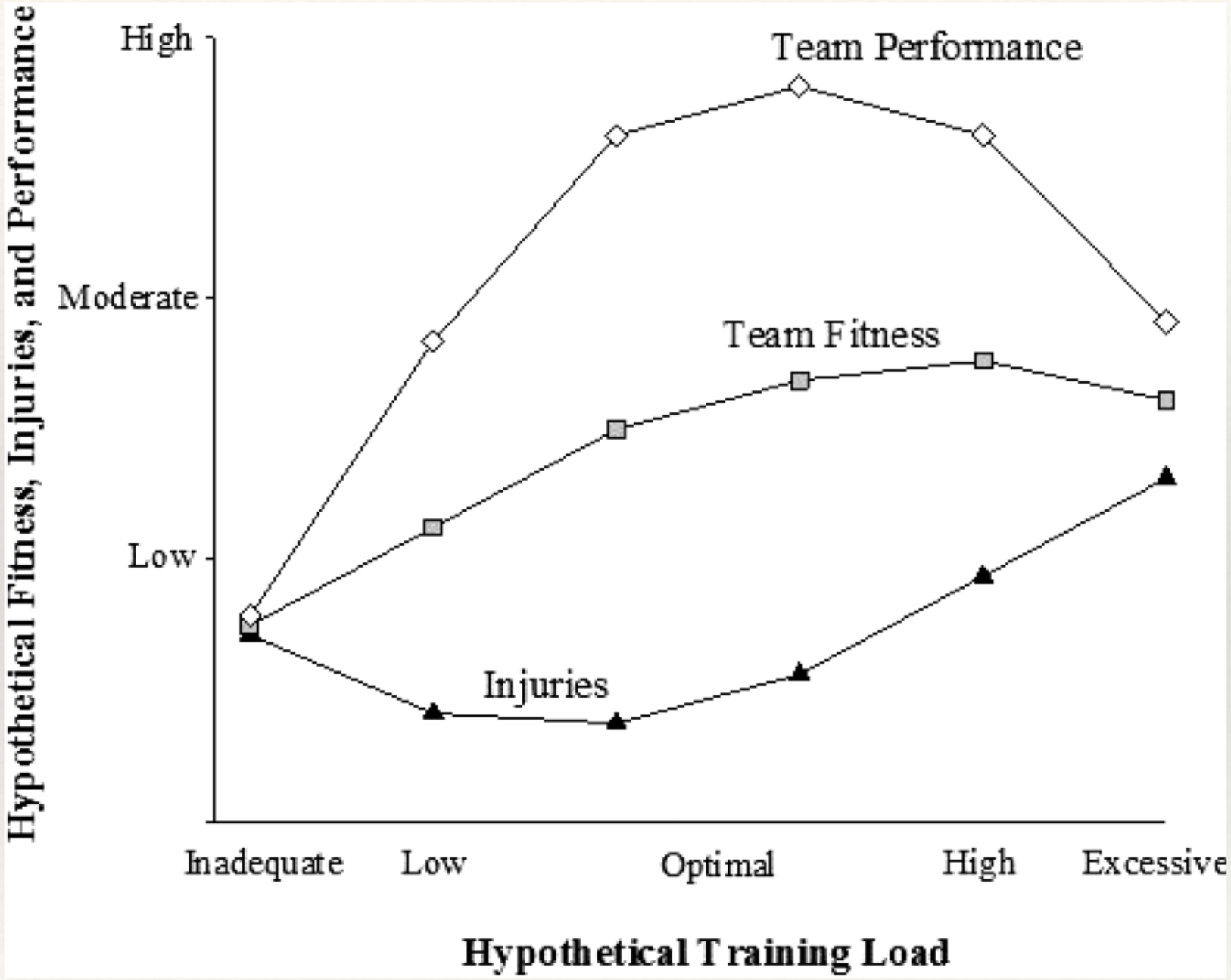
| Training type | n | Coach | Athlete | Correlation |
|---|---|---|---|---|
| Recovery | 100 | 1.87±0.8 | 2.17±0.8 | 0.35; p=0.002 |
| Base training | 121 | 3.61±0.63 | 3.50±1.0 | 0.25; p=0.006 |
| Speed+Interval | 61 | 6.64±2.0 | 5.57±1.81 | 0,718; p=0.000 |
| Total | 282 | 3.65±2.0 | 3.48±1.7 | 0.798; p=0.000 |

Heinsoo, 2015

# RPE and internal training load



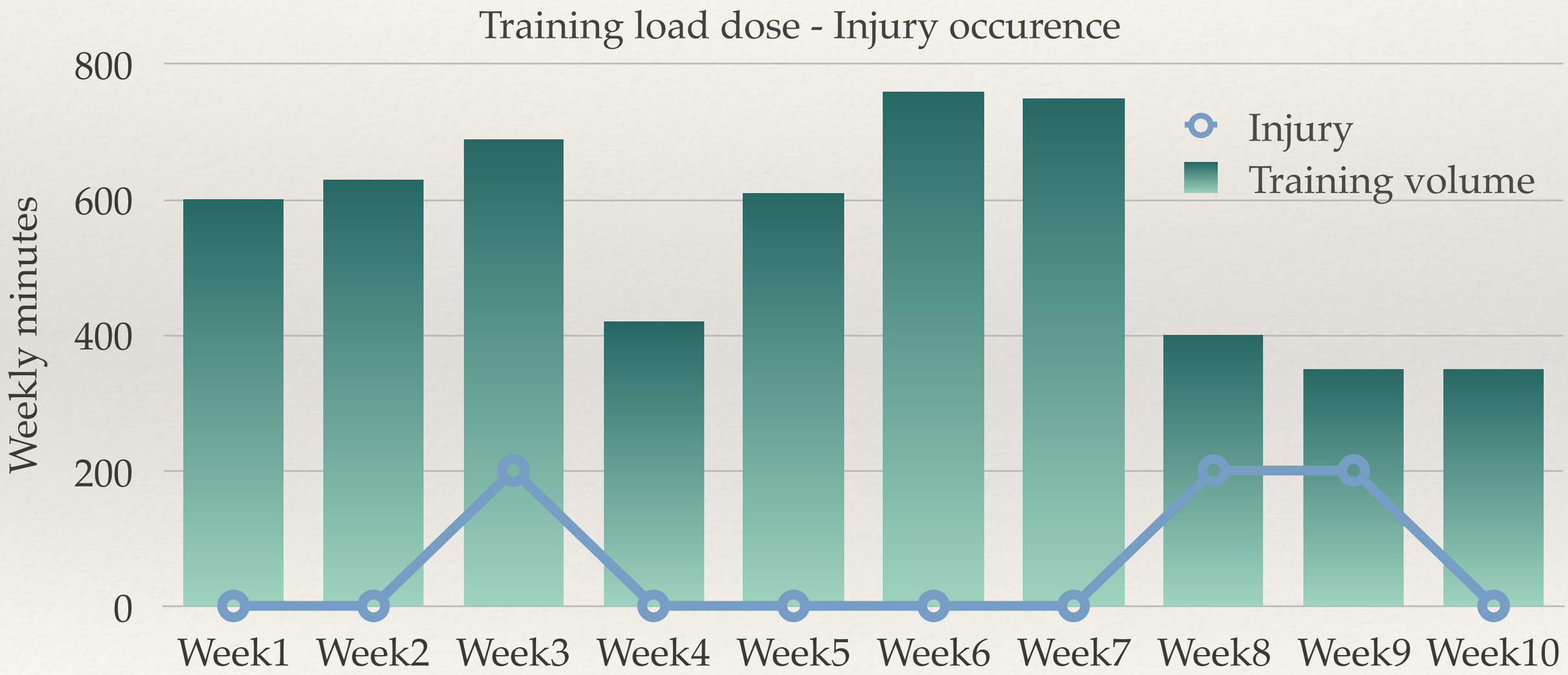
# Training load - performance-injury




Orchard, 2012

# How to monitor data?

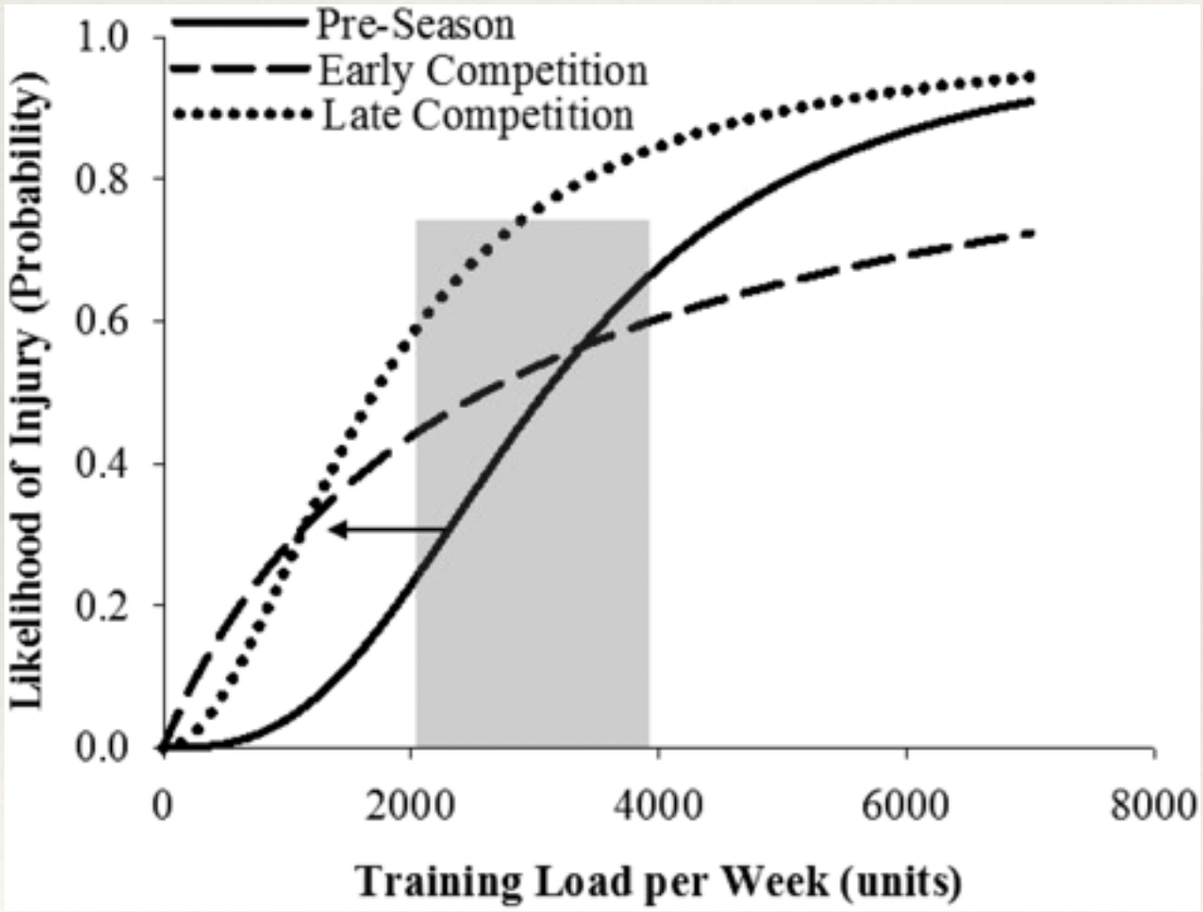
High absolute training loads are associated with greater injury risk.



# Can we predict injury?

2- year study period
Session RPE-likelyhood of injury

Additional 2 years to determine
if non-contact soft tissue injuries
could be predicted




True positive - predicted injury - injured **67**%

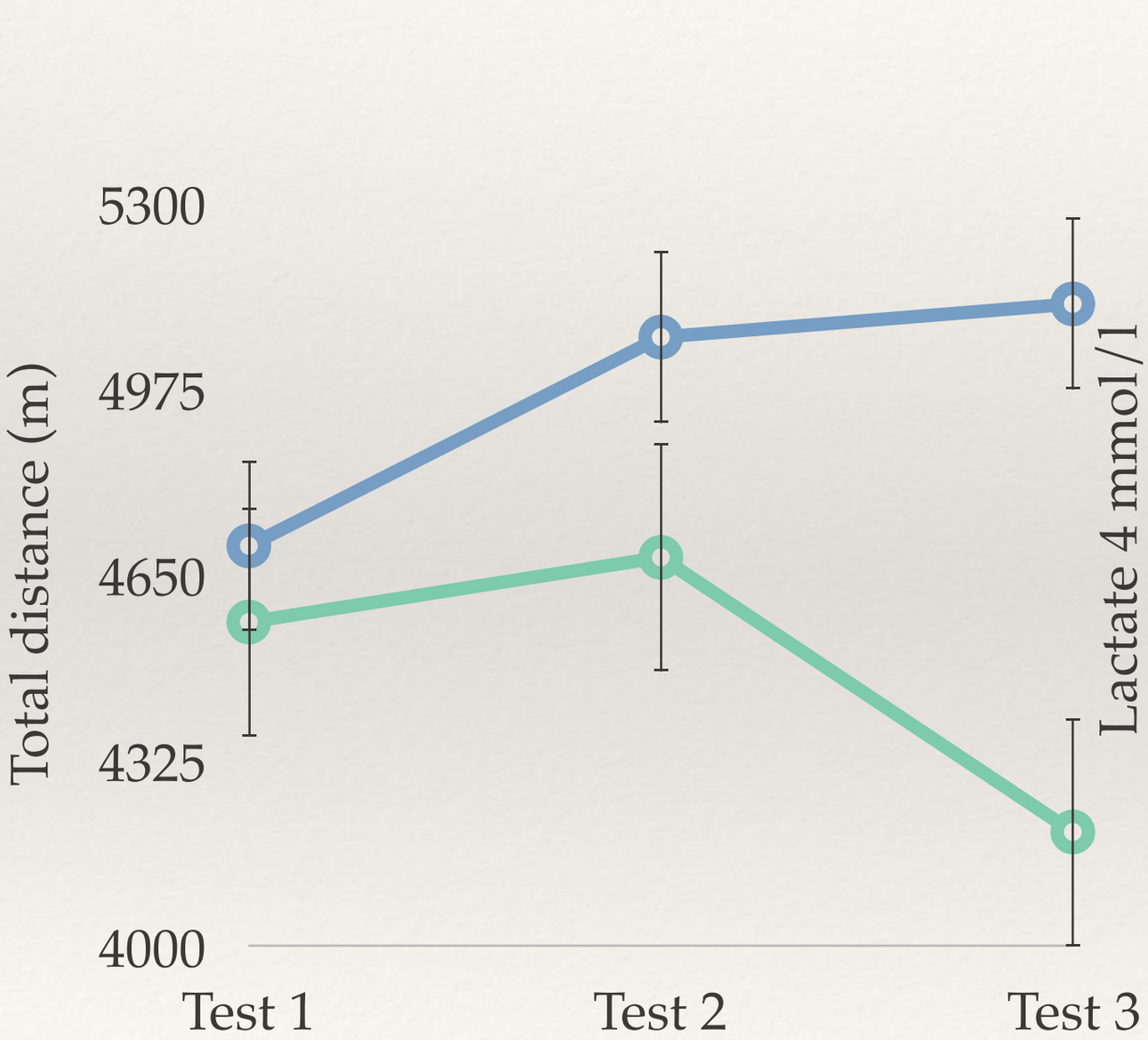
False positive - predicted injury - not injured 13%

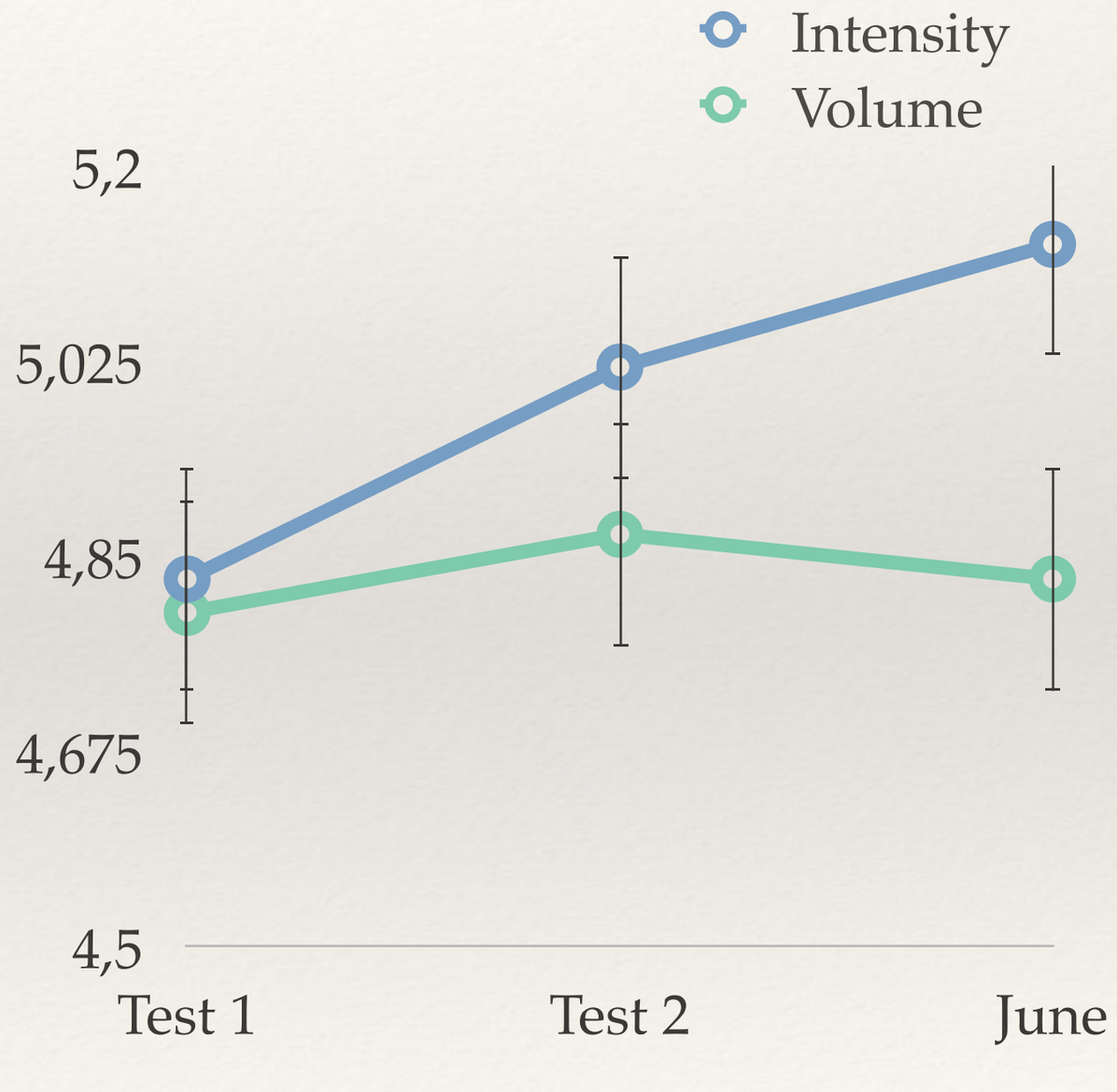
False negative - no predicted injury - injured 11%

Positive predictive value 85%
Negative predictive value 98.9%

Gabbet, 2010

# Temporal changes in training load

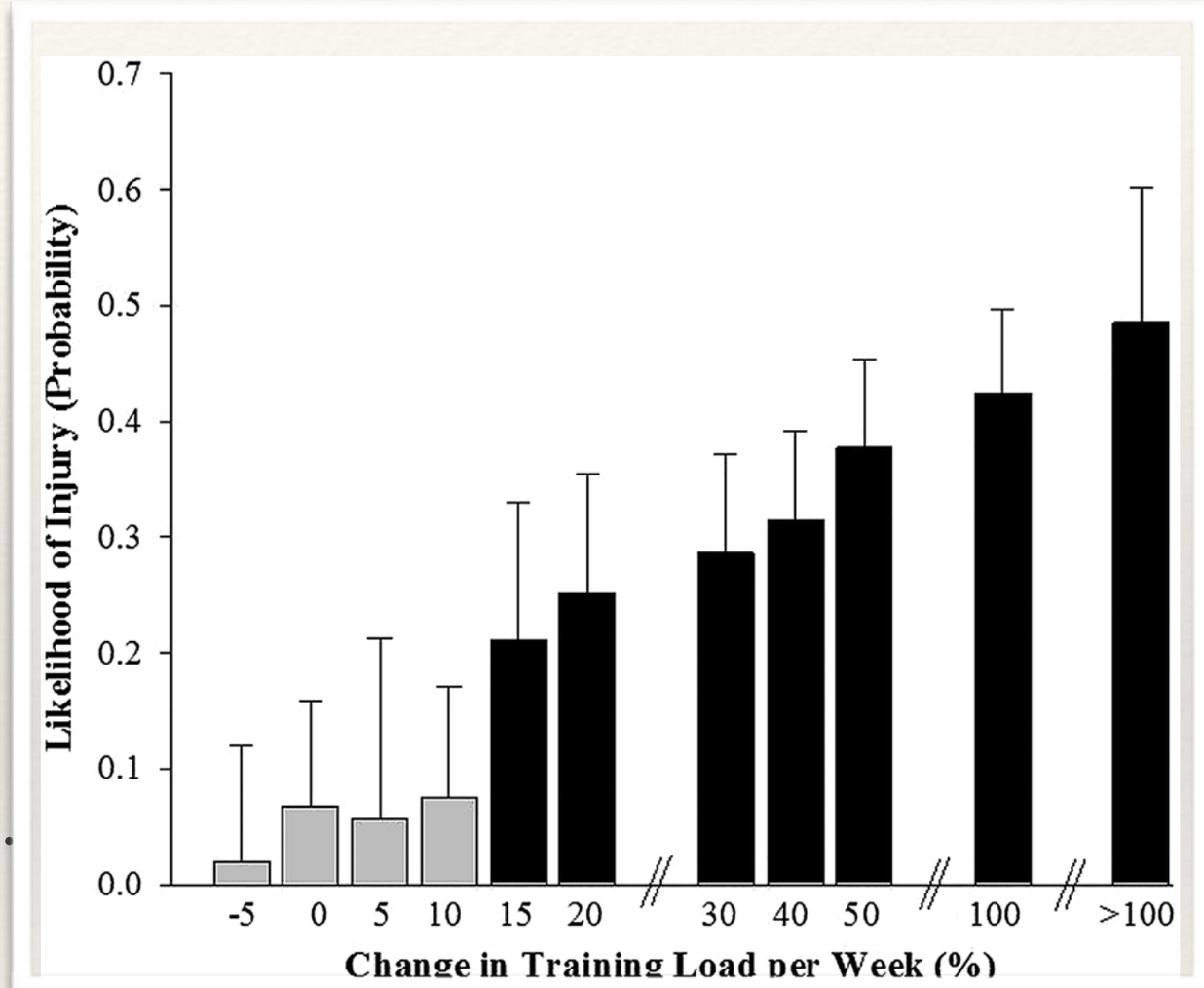



Lehmann et al. 1997

# Temporal changes in training load - Injury risk

- 40% of injuries were associated with rapid changes in training load (>10%) compared to preceeding week in football players (Piggott et al 2009);
- If the change is higher than than 1100 to 1200 AU in absolute values (Cross et al 2015; Rogalski et al 2013).



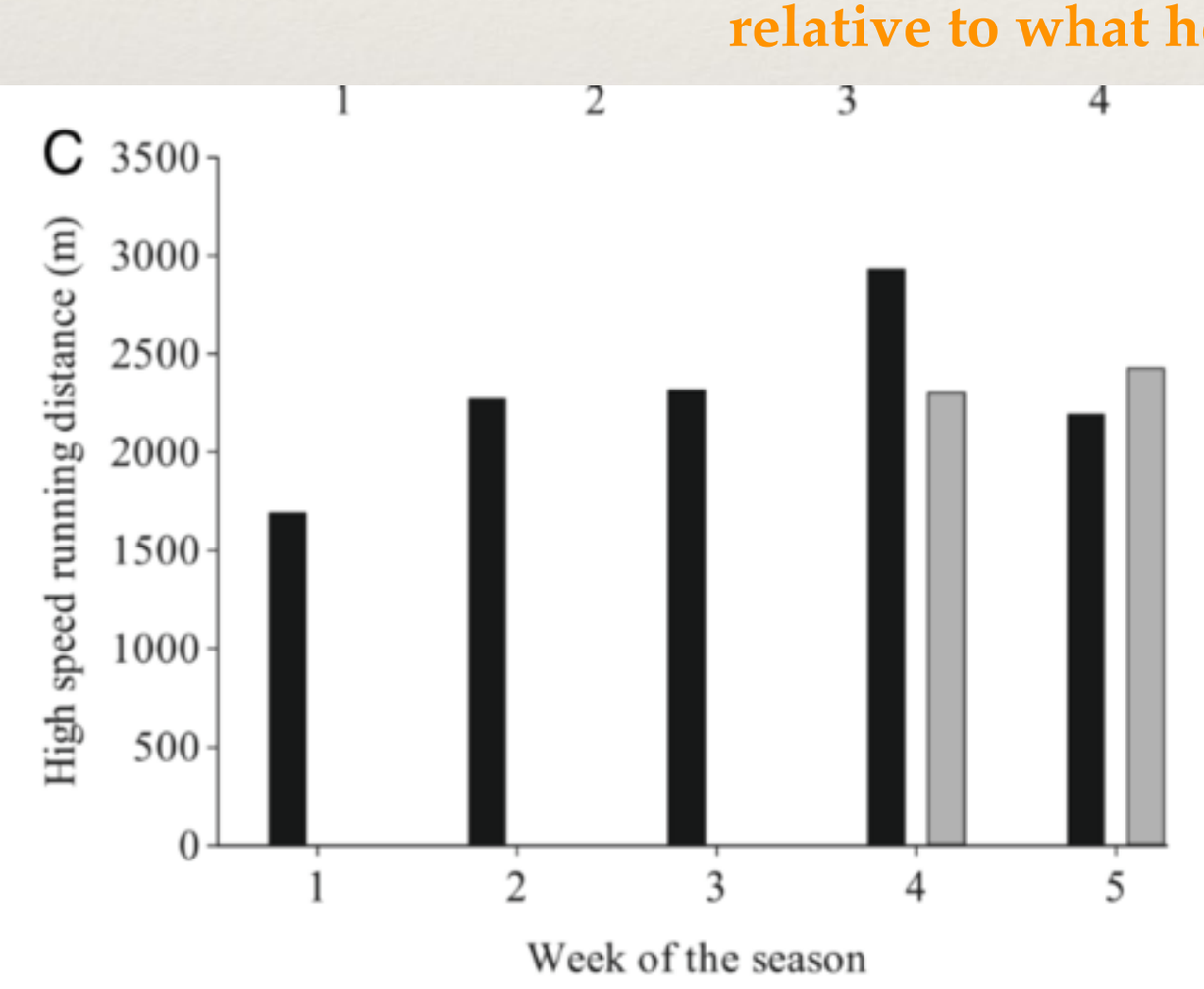

Gabbet, 2016

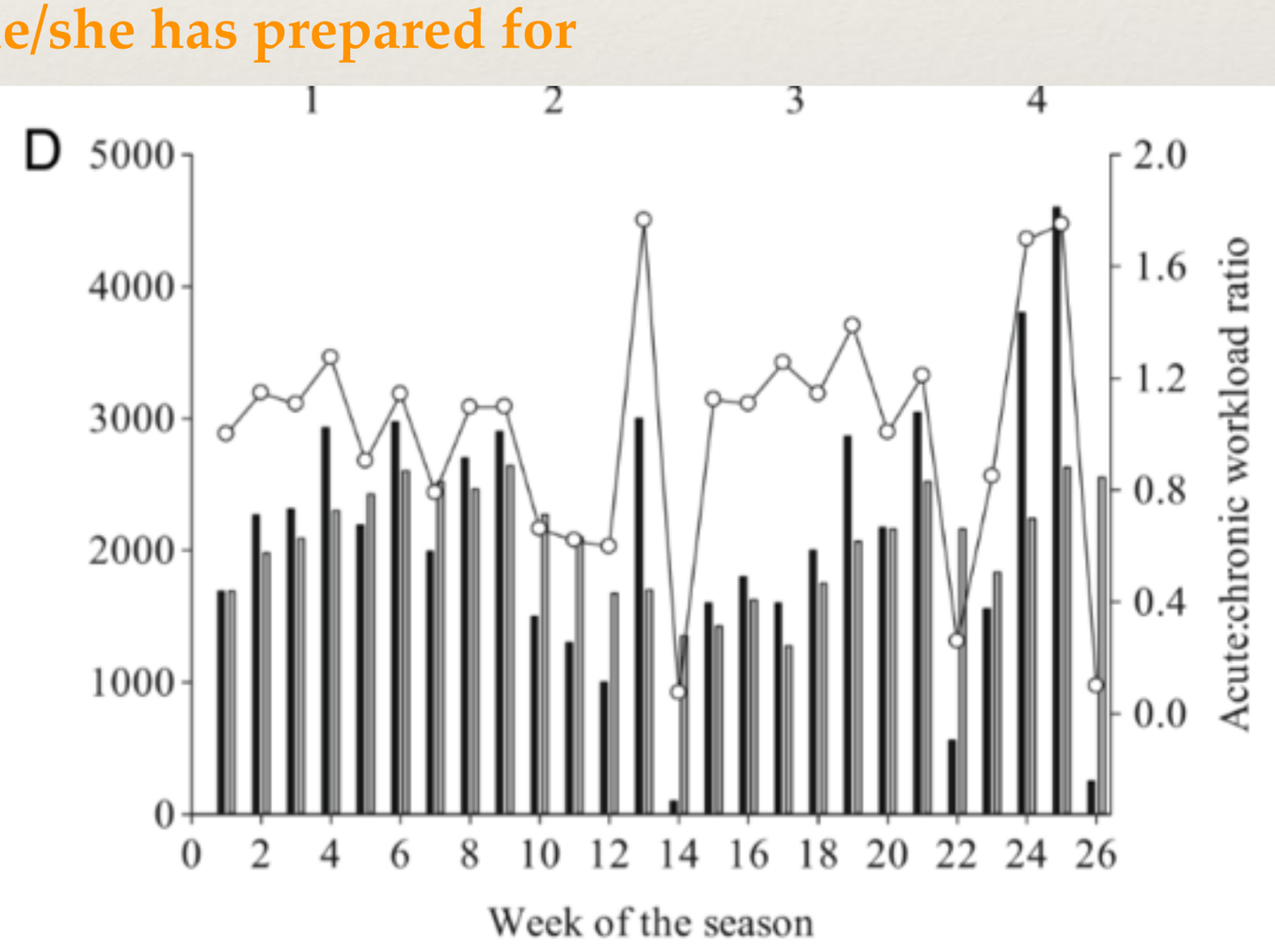
**To minimize the risk of injury**
**do not exceed weekly load increases greater than 10%**

# Acute vs Chronic Load

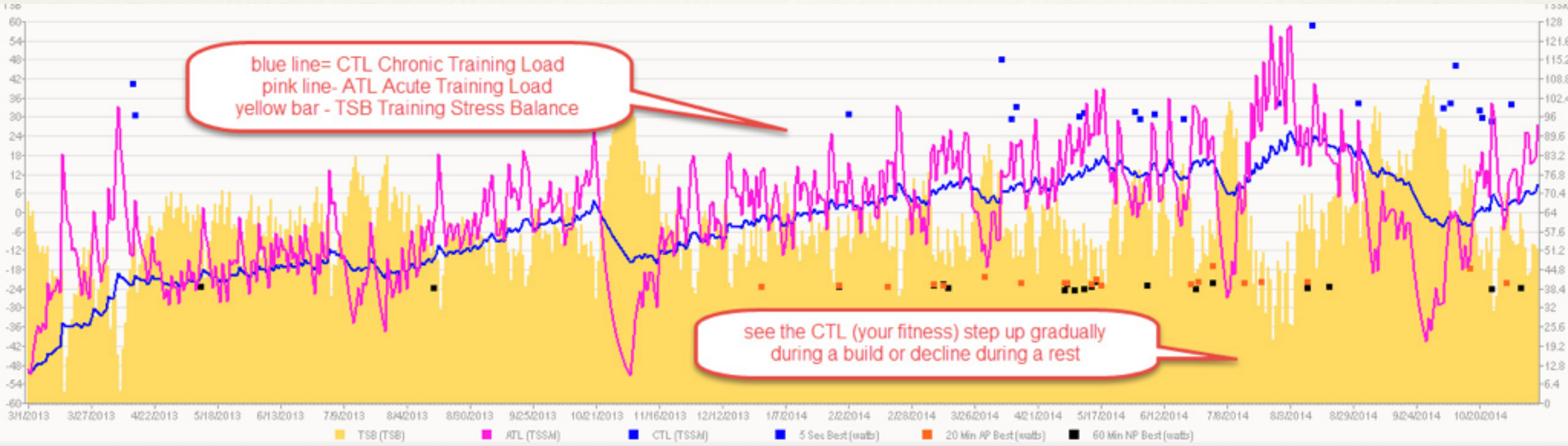
- Acute load - average weekly load  FATIGUE
- Chronic load - average of previous 28-40 days  FITNESS

**Emphasises the load that the athlete has performed relative to what he/she has prepared for**



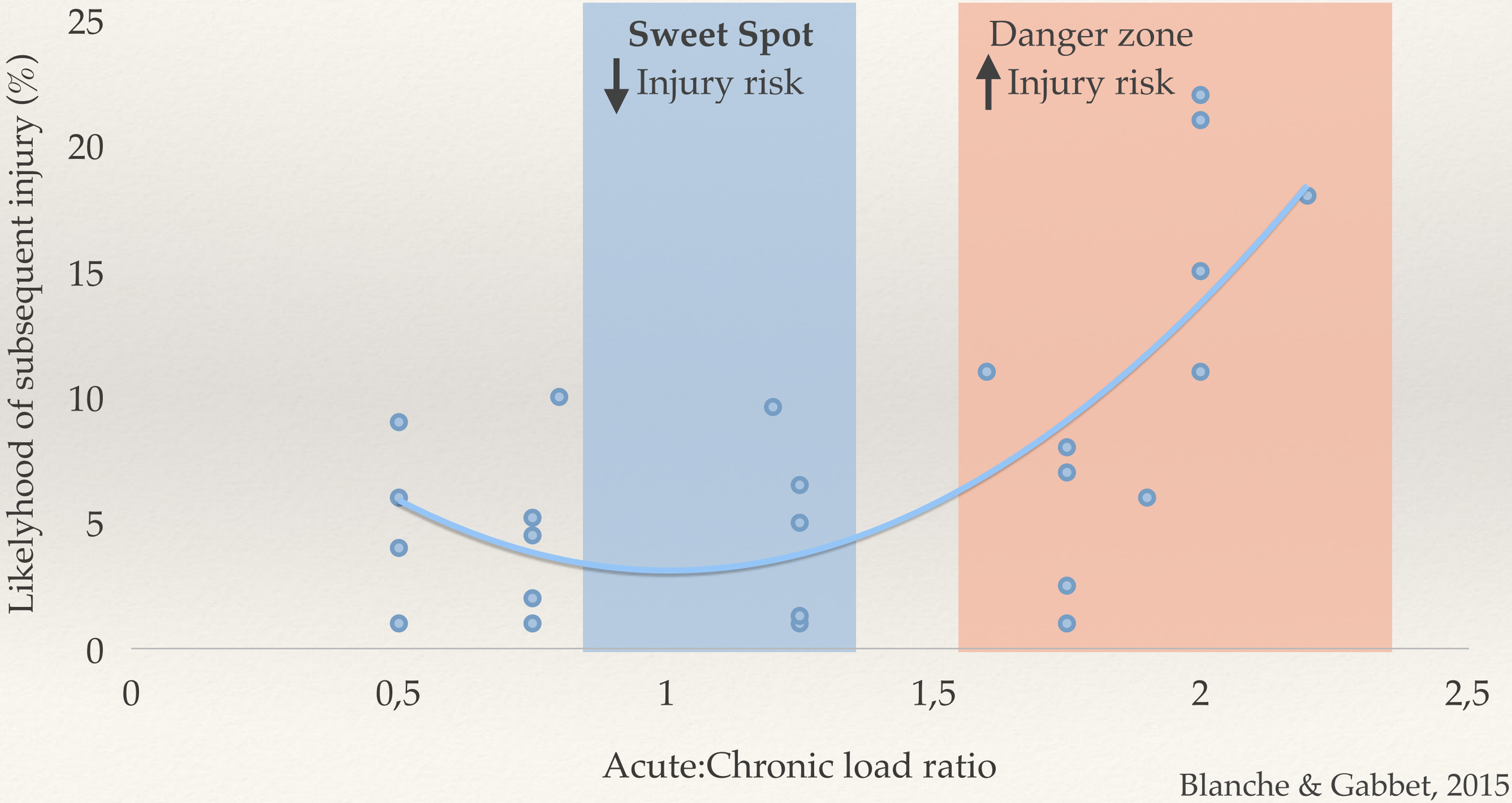



# Acute:Chronic Load



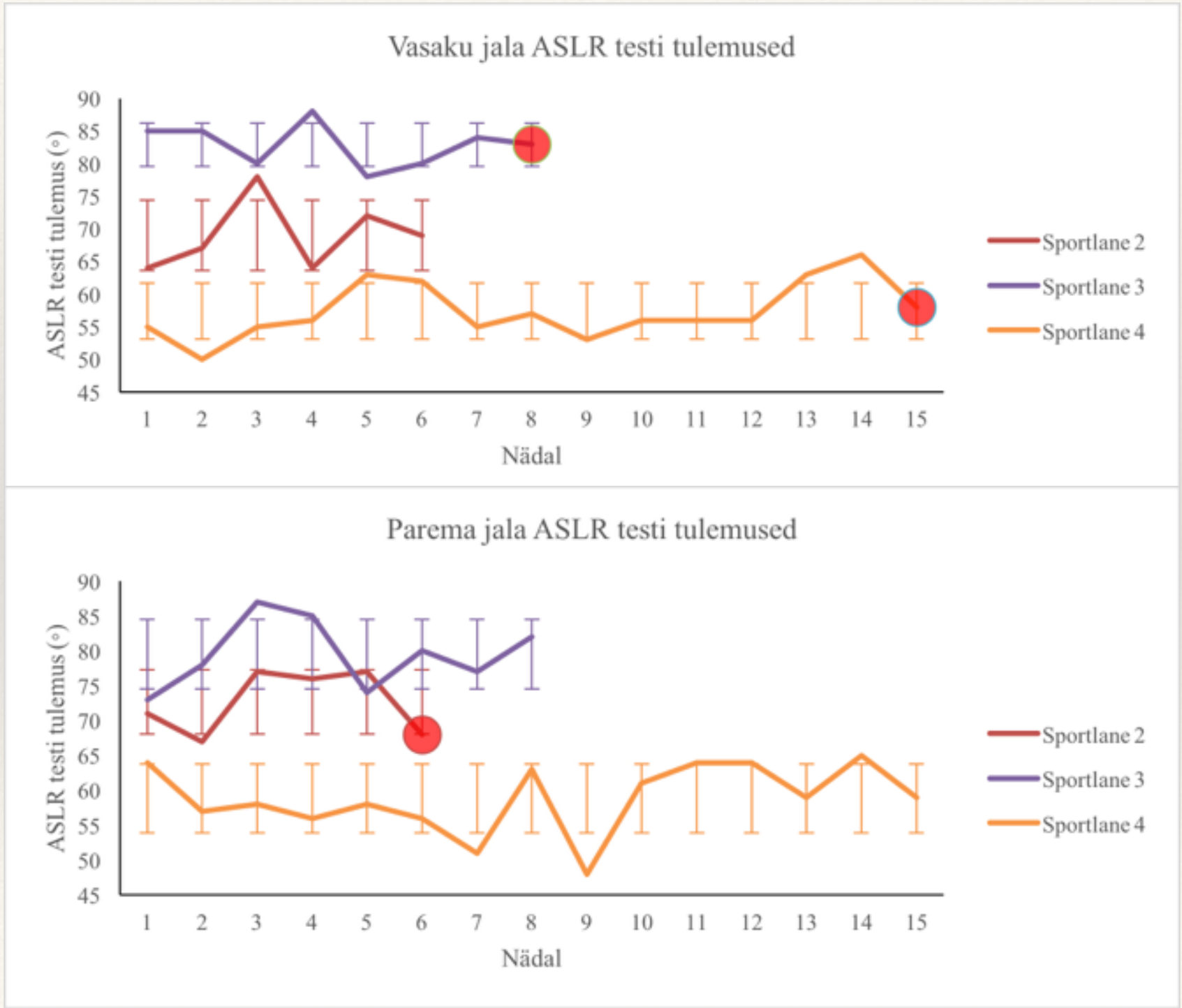

redrawn from Hunter

# The “Sweet Spot”




Blanche & Gabbet, 2015

# Active Straight Leg Raise



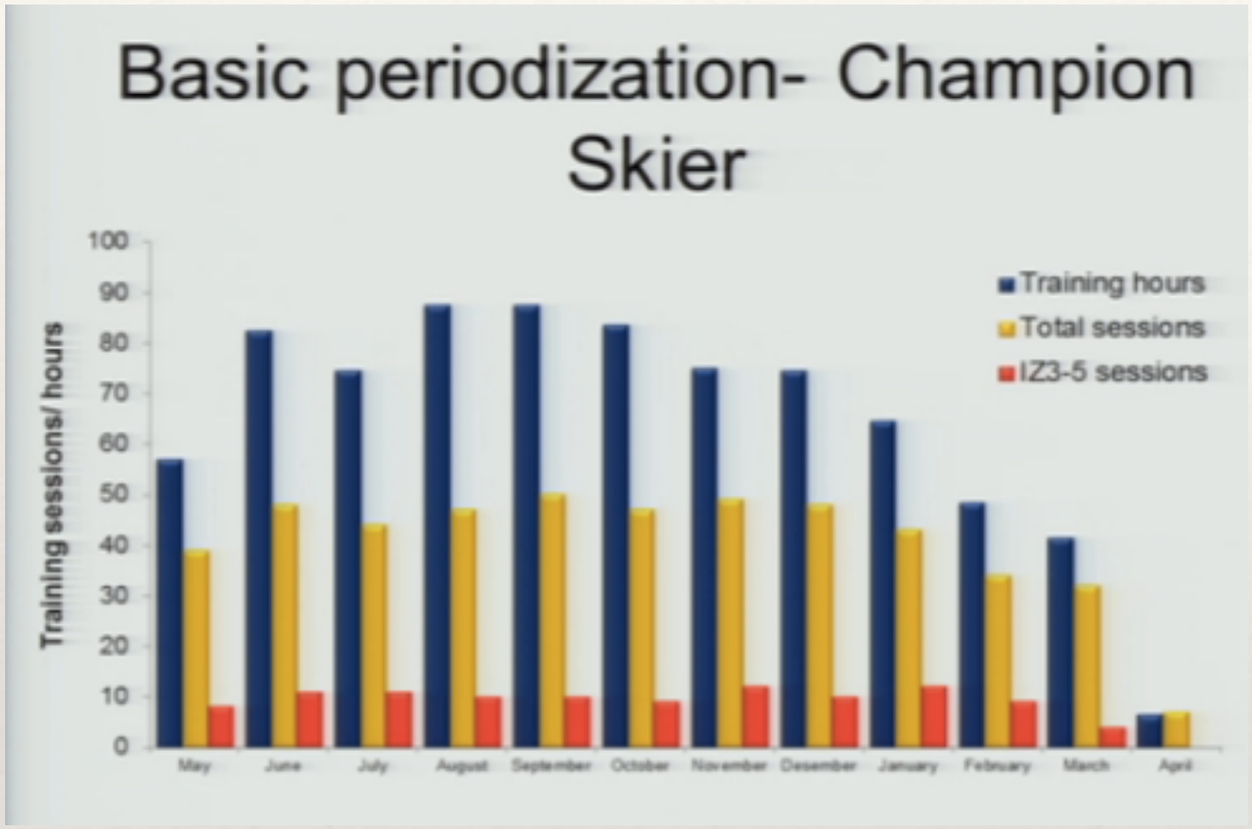

Kalev, 2015

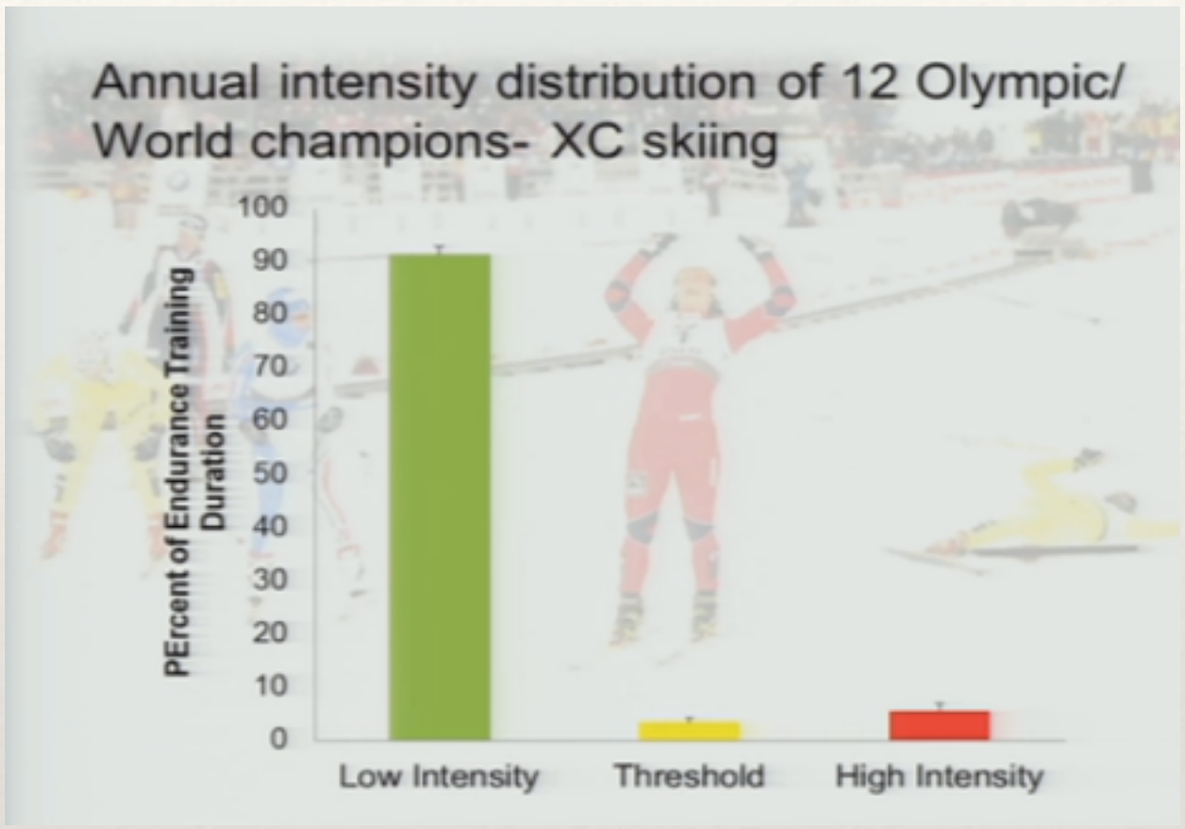
# Internal workload and injury risk

| Risk factors | Transient |
|---|---|
| Injury history in the previous season (no vs yes) | 1.4 (0.6 to 2.8) |
| Total distance (≤3910 vs >3910 m) | 0.6 (0.3 to 1.4) |
| Very low intensity (≤542 vs >542 m) | 0.6 (0.2 to 1.3) |
| Low intensity (≤2342 vs >2342 m) | 0.5 (0.2 to 1.1) |
| Moderate intensity (≤782 vs >782 m) | 0.4 (0.2 to 1.1) |
| High intensity (≤175 vs >175 m) | 0.8 (0.2 to 3.1) |
| Very high intensity (≤9 vs >9 m) | 2.7 (1.2 to 6.5)* |
| Total high intensity (≤190 vs >190 m) | 0.5 (0.1 to 2.1) |
| Mild acceleration (≤186 vs >186 m) | 0.2 (0.1 to 0.4)† |
| Moderate acceleration (≤217 vs >217 m) | 0.3 (0.1 to 0.6)† |
| Maximum acceleration (≤143 vs >143 m) | 0.4 (0.2 to 0.8)* |
| Repeated high-intensity effort bouts (≤3 vs >3 bouts) | 0.9 (0.4 to 2.0) |

Gabbet & Ullah, 2012

# Training load distribution




Seiler, 2013

# Conclusion

- Training has both positive and negative effects;
- There is a relationship between high training loads and injuries;
- The ratio of acute to chronic training load is better predictor of injury than acute or chronic loads in isolation;
- This is an ongoing process with lot's of adaptations.

"Can we win the championships if we have the best knowledge from sport science, best coaches available and best equipment? NO.
But if we do not have it, we can loose the title"

*Chris Carmichael*

# THANK YOU FOR YOUR ATTENTION!