



Load management... an epidemiology perspective

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Maximise our chance NOW through being pro-active

- Best Planned
 - Training load **peaks** and **troughs**, are known to **cause injury and illness** (and reduce chance of success)
- Best Prepared
 - Individualised, **consistent** and progressive training **loads** are conducive to **performance outcomes**
- Best Performed
 - Linked to **uninterrupted training**

How much 'Modified Training' affects Performance?

Scatter plot graph Key points

- How does lost training time due to injury or illness affect Performance outcome?
 - Do we have a benchmark for this? Yes
- Benchmark is <20% of training weeks (5.2 wks) modified in the 6-months (26 wks) before the major international championships
 - If modified <20% there is a 7x greater likelihood for achieving the performance goal relative to this modified >20%
- In Raysmith & Drew 2015 (in review, BJSM). Of the 76 athlete seasons recorded over 5yrs, on only 2 occasions has an athlete been modified >20% and successfully achieved their performance goal.

Key articles

- Hagglund et al (2013)
 - UEFA, 11 year study shows match availability rate of players important for team success
- Podlog et al (2014)
 - NBA, 25 years
 - Inverse relationship between missed games due to injury/illness and percentage of games won
 - Ie those with high team injury rates did not succeed
- Raysmith and Drew (in review, BJSM)
 - T&F, 5 years
 - Training availability predicts who succeeds in reaching their performance goals for the season

Sayings...

“We need to break them to know their limits”

Response:

Moderate evidence showing rapid changes in loads (spikes) are predictive of future injury

Does relative load influence risk?

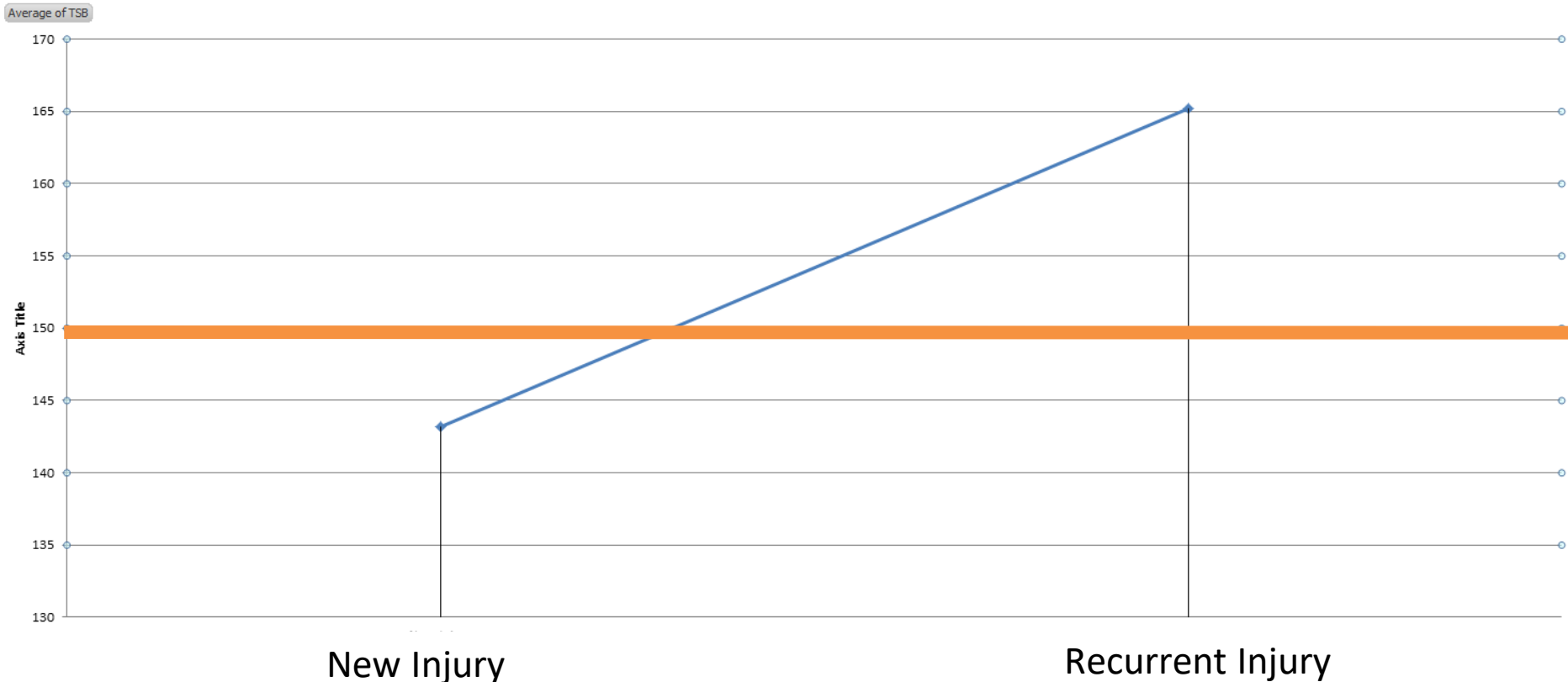
Avg TSB Across All Injuries by Body Area

(Note – requires regular load data for each sport, this more for interest)

Yes! On average athletes get injured at a training stress balance of approximately 150.

Beware reloading strategies

Avg TSB Across All Injuries by Classification
 (Note – requires regular load data for each sport, this more for interest)



We hypothesise this to be related to the chronic training load at the time of injury. That is, those coming back from injury have a lower base and risk overshooting their acute loads more easily

Load v Injury or Illness

- 19 articles exist for the relationship between loads and injury or illness



How good is the evidence?

Moderate evidence

- Training loads and injury incidence in the majority of studies (n=16, 84.2%)

- Training loads in throwing sports

1	Strong evidence	Consistent findings in multiple high-quality RCTs
2	Moderate evidence	Consistent findings in one high-quality RCT and in one or more low-quality RCTs, or consistent findings in multiple low-quality RCTs
3	Limited evidence	Only one RCT (of high or low quality)
4	Conflicting evidence	Inconsistent findings in multiple RCTs

Source: After Van Tulder *et al.* (2000), cited in Roozen *et al.* (2004)

How good is the evidence?

Conflicting evidence

- Training loads and illness
 - significant relationship (n=1)
 - no relationship (n=2)

“We break them early in the season”

Response:

Subsequent injuries are common and account for 37-43% of injuries in Australia^{1,2}

Athletes are more likely to sustain more than one injury (median=2 injuries, range 0-6)¹

The data would agree...

INJURIES BY GENERAL LOCATION	
Row Labels	Count of General Location
<input type="checkbox"/> Competition - Domestic	9.23%
New Injury	7.85%
Recurrent Injury	1.39%
<input type="checkbox"/> Competition - International	11.24%
New Injury	9.52%
Recurrent Injury	1.72%
<input type="checkbox"/> DTE - Domestic	61.87%
New Injury	45.93%
Recurrent Injury	15.93%
<input type="checkbox"/> DTE - International	17.66%
New Injury	12.92%
Recurrent Injury	4.74%
Grand Total	100.00%

79.53% of injuries are sustained in DTE

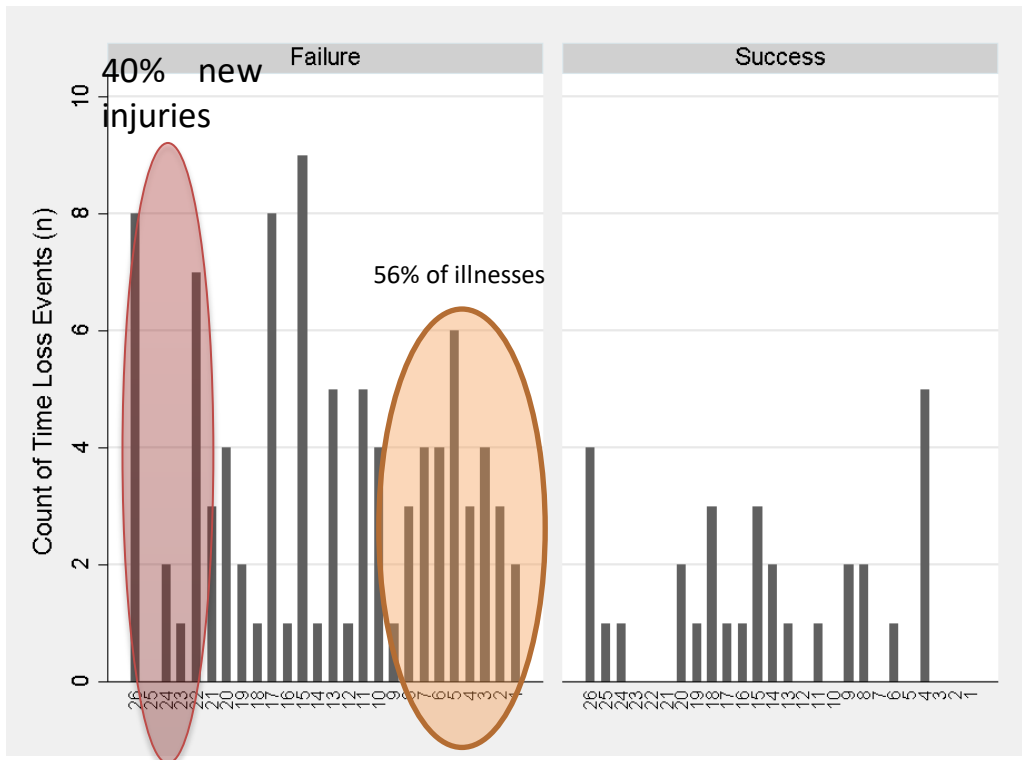
“We break them early in the season so it doesn’t affect performance”

Response:

Athletes who sustain ≥ 2 training time-loss events are 68% less likely to reach their season goal and 1.8x more likely to fail¹

(Remember ... athletes are likely to get more than one injury/illness...)

Athletes (T&F) are 4x more likely to sustain a competition time-loss injury if they sustain an injury in the month prior to the World Championships



Our paper showed that almost all “index injuries” (first injuries) did not occur in the last month with 40% occurring 6 months out.

Therefore, what you do early in the season might set the athlete up to succeed or fail.

“We need to teach them what hard work is”

Response:

Fair point.

Could you not build to these loads over a period of time (4-6 weeks) not one week...

“We use junior athletes to determine the risk for the seniors”

Response:

Fair point, but previous injury is the largest risk factor for future injury.

Junior athletes will be Olympians one day carrying bags of injuries.

Athlete Pathways survey has shown injury is one of the main reasons why talent juniors do not progress to podium levels.

“Physios are only trying to reduce the loads...”

Response:

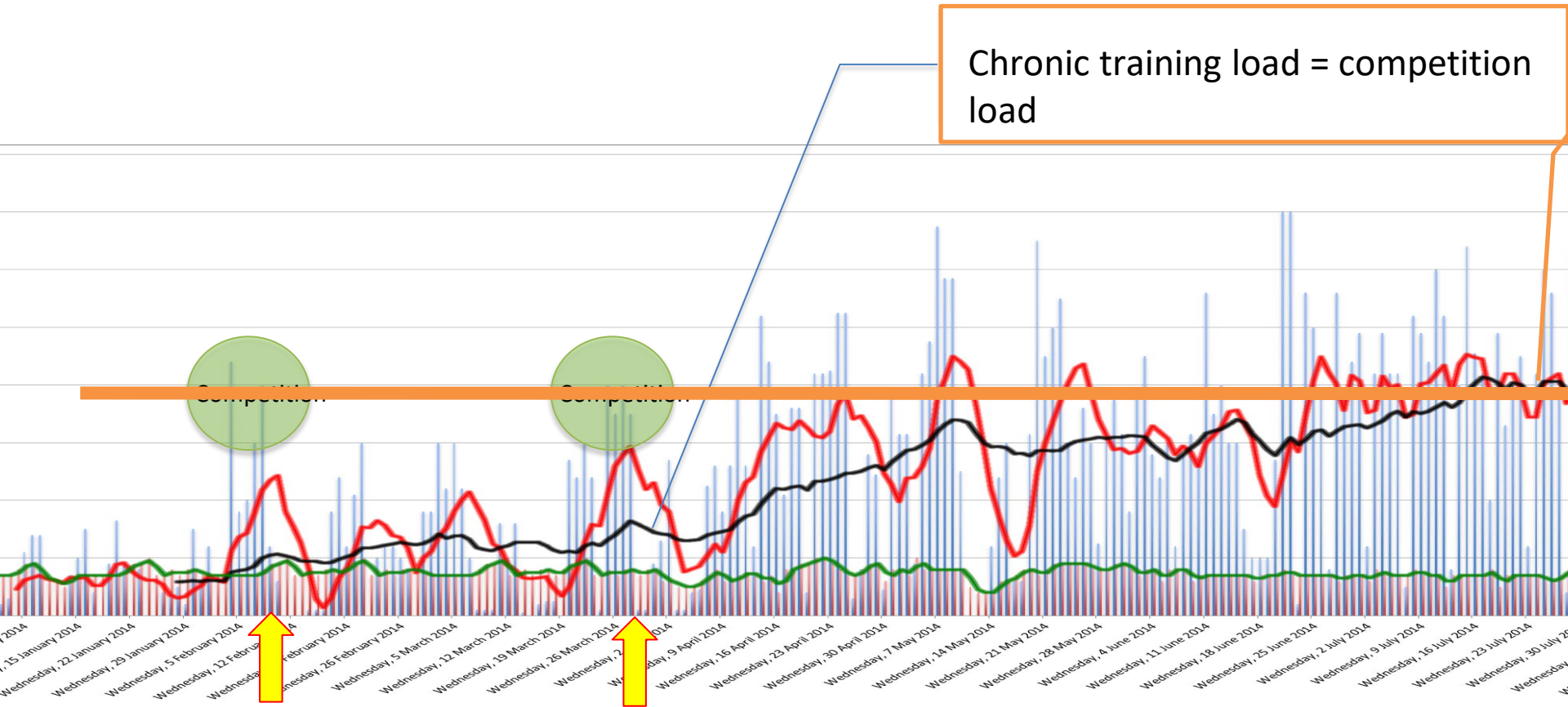
Historically (probably) correct.

Now we know spikes and troughs are where the risk is imposed not absolute loads.

We want athletes to be able to do high loads... but we need to get them there safely.

Load monitoring does not mean doing less...

In most cases it means doing more
(over a longer period)



WHAT IS LOAD MONITORING?

What is load monitoring?

- The application of quantifying the amount of physical training that an athlete undertakes
- Responses are either positive
 - Increased fitness and performance
- Or negative 📷
 - Injury, illness, reduced performance

WHAT IS LOAD?

The image features a dark blue background. In the bottom right corner, there is a decorative graphic consisting of several parallel, diagonal lines in a slightly lighter shade of blue, creating a sense of depth and movement.

Measures of Load

Internal

- Perceived exertion
- Physiological Stress
- RPE x time

External

- Loads external to the athlete
 - Distance, Watts, Duration etc.
- Devices
 - GPS, Watt Meter, etc

Which one is best?

It simply **depends** on the **output** you want to **measure**

Do you want to **quantify training**?

Do you want to **predict outcomes**?

Rate of Perceived Exertion

- RPE is closely related to
 - Lactate measures
 - Heart rate
- RPE is reliable for quantifying resistance training loads and field sessions


Table 1. Modified Borg scale used for rating perceived exertion (Foster et al. 1996).

Rating	Verbal descriptions
0	Rest
1	Really easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Really hard
8	
9	Really, really hard
10	Maximal

Note: Thirty minutes following the completion of a training session the athlete must describe the overall perception of effort during the session.

Calculating the Loads

Must include all the components of a training program.



Day	Training	RPE	Time	Volume	Total
Mon	Weights Speed/Skills	6 4.5	45 60	270 270	540
Tues	Team Skills/ Condition	8	70	560	560
Wed	Recovery	0	45	0	0
Thurs	Weights Skills/Game scenarios	5 4.5	35 50	175 225	400
Fri	Light Skills	3	30	90	90
Sat	Game	8.5	80	680	680
Sun	Recovery	2	30	30	60
				Total	2330

Training Stress Balance

(Fitness-Fatigue)

- Fitness (chronic load) is the average training load of the last 4 weeks
- Fatigue (acute load) is the training load of the last week

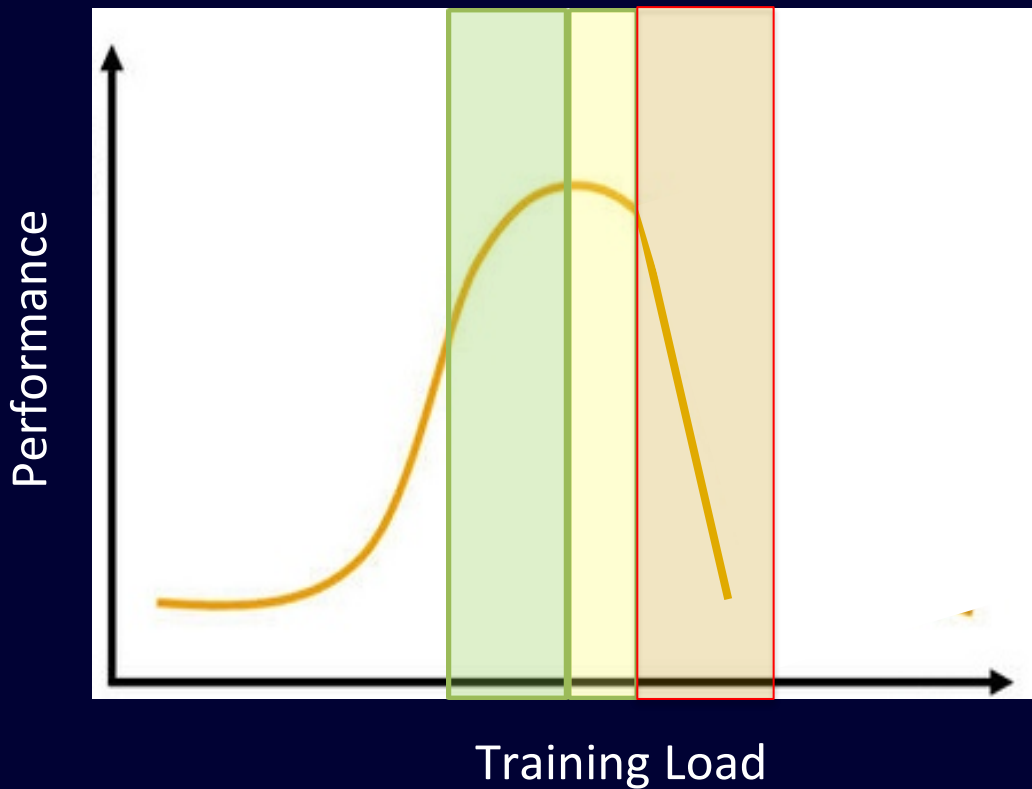
$$\text{TSB} = \text{acute} / \text{chronic}$$

(expressed a percentage)

For example: acute = 900, chronic = 600

$$\text{TSB} = 900 / 600 = 150\%$$

Optimal Loading



Hypothetical Zones

Optimal Zone

Diminishing returns

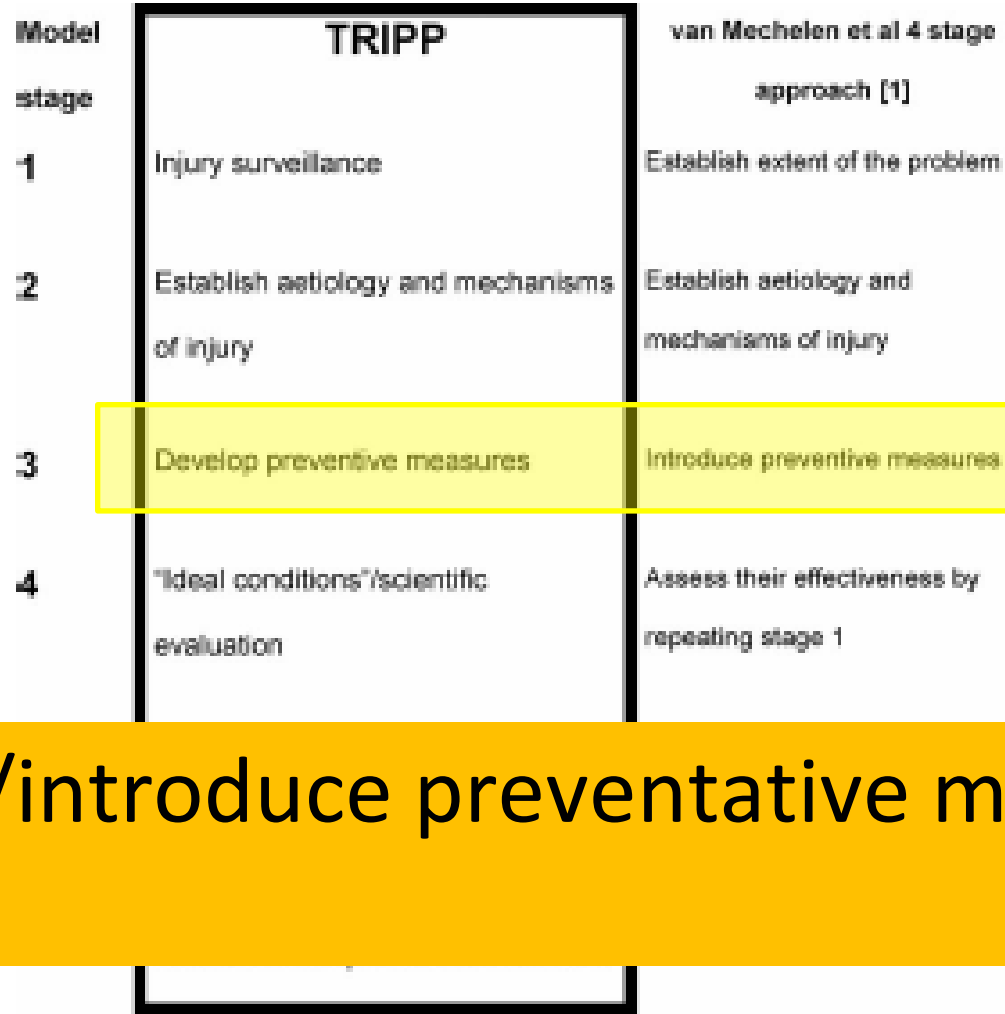
Risk Zone and negative returns

Please note this is a hypothetical graph based on current research

WHERE DOES LOAD MONITORING FIT INTO THE TRIPP MODEL?

Model stage	TRIPP	van Mechelen et al 4 stage approach [1]
1	Injury surveillance	Establish extent of the problem
2	Establish aetiology and mechanisms of injury	Establish aetiology and mechanisms of injury
3	Develop preventive measures	Introduce preventive measures
4	"Ideal conditions"/scientific evaluation	Assess their effectiveness by repeating stage 1
5	Describe intervention context to inform implementation strategies	
6	Evaluate effectiveness of preventive measures in implementation context	

Fig. 1 The Translating Research into Injury Prevention Practice (TRIPP) framework for research leading to real-world sports injury prevention.



Develop/introduce preventative measures

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Develop/introduce preventative measures

Primary Prevention

Secondary Prevention

Tertiary Prevention

Remove Risk Factors

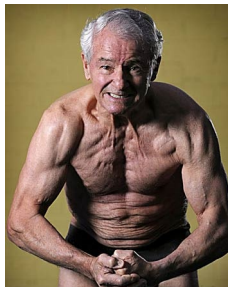
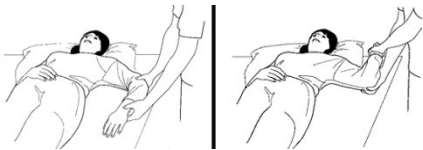
Early Detection, Early Treatment

Remove Complications



Risk Modifier (modifiable)

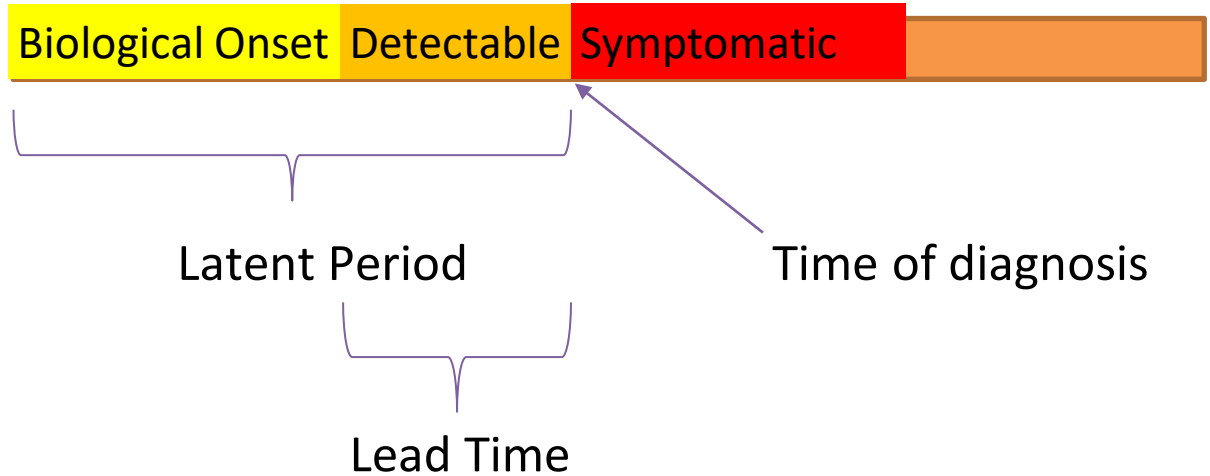
Baseline Risk (non-modifiable)



Develop/introduce preventative measures

Secondary Prevention

Early Detection, Early Treatment



Screening models in epidemiology

Primary Prevention

Secondary Prevention

Tertiary Prevention

Remove Risk Factors

Early Detection, Early Treatment

Remove Complications



Risk Modifier (modifiable)



Baseline Risk (non-modifiable)



Latent Period

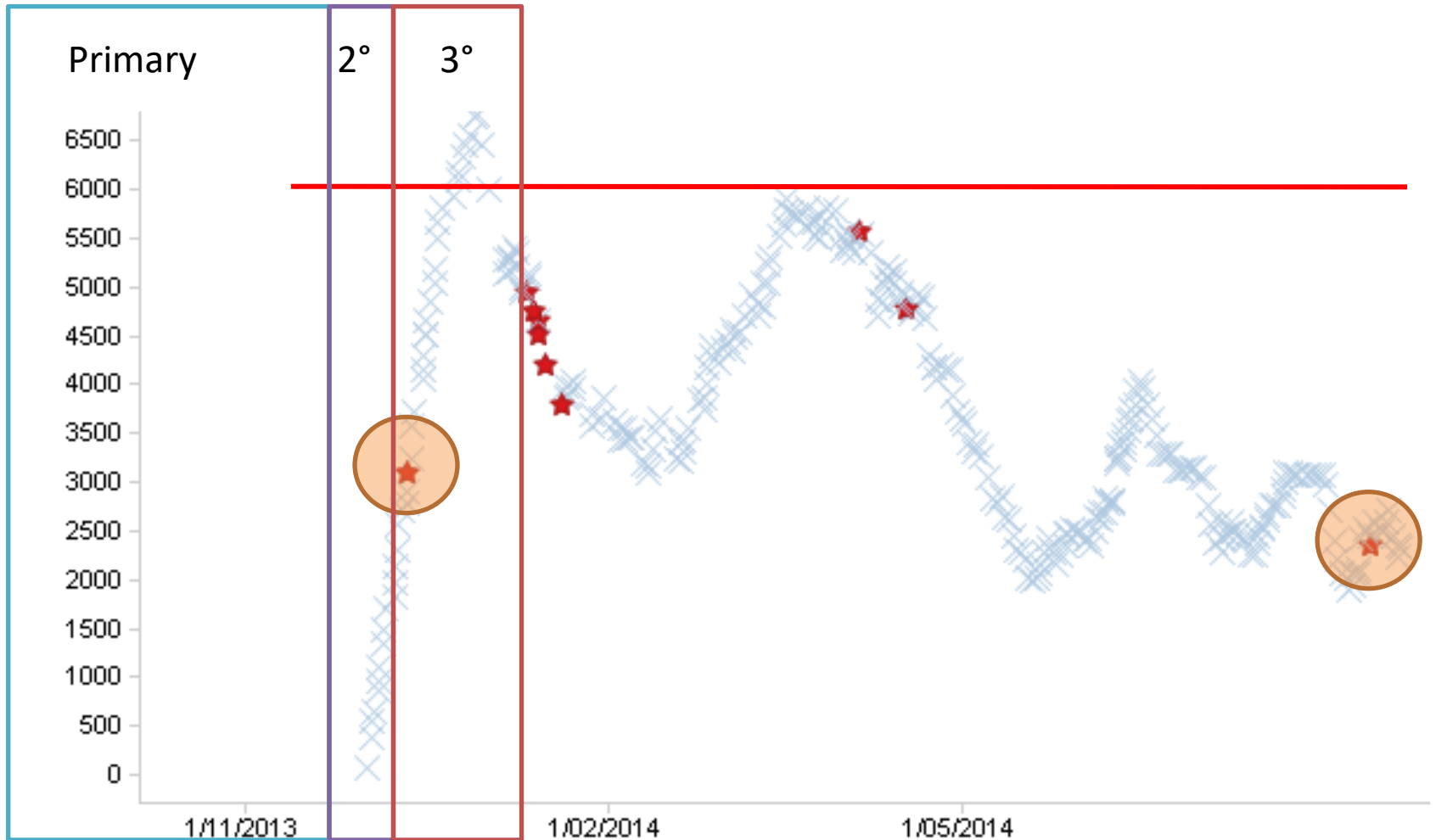
Lead Time

Reduce Recurrence

Reduce Subsequent Injuries

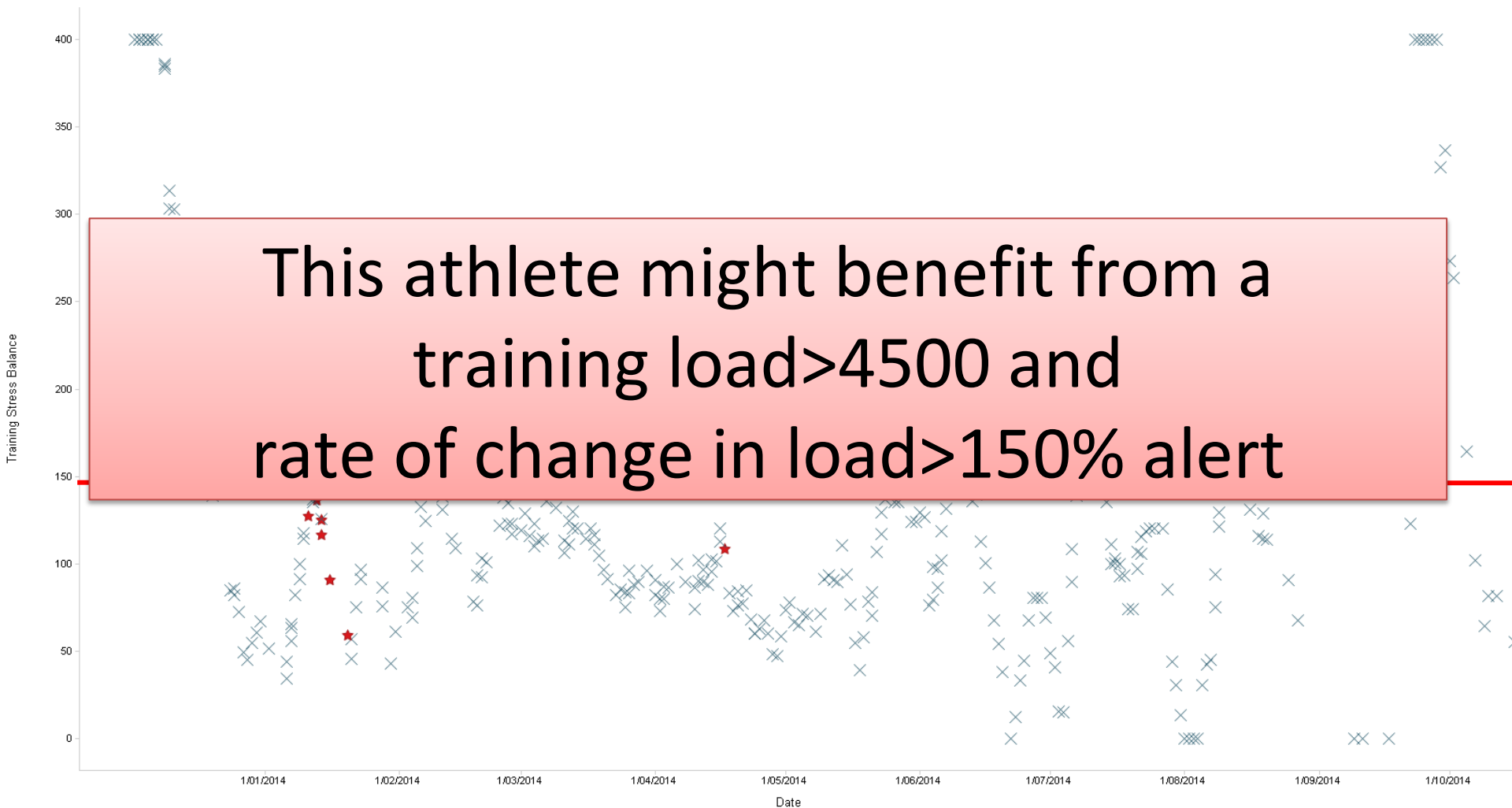
Reduce time between latent and lead time

For example...



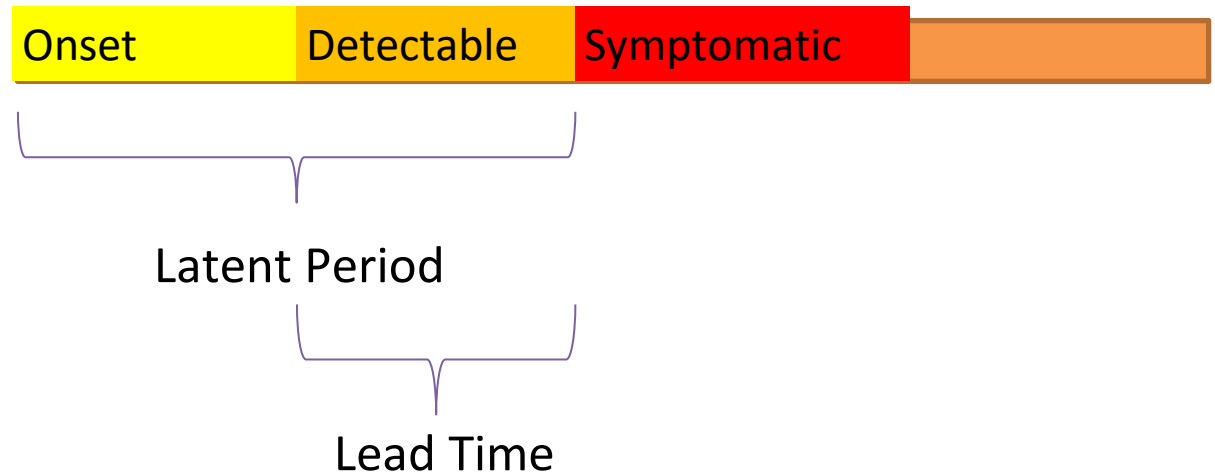
Maybe it's the change in load?

Relative Load and Injury



Take home message

- Identify the variable(s) with predictive capacity
- Apply these during the “lead time” as this is the period where you can have the most impact



**WHAT DOES THE RISK LOOK
LIKE?**

Editorials

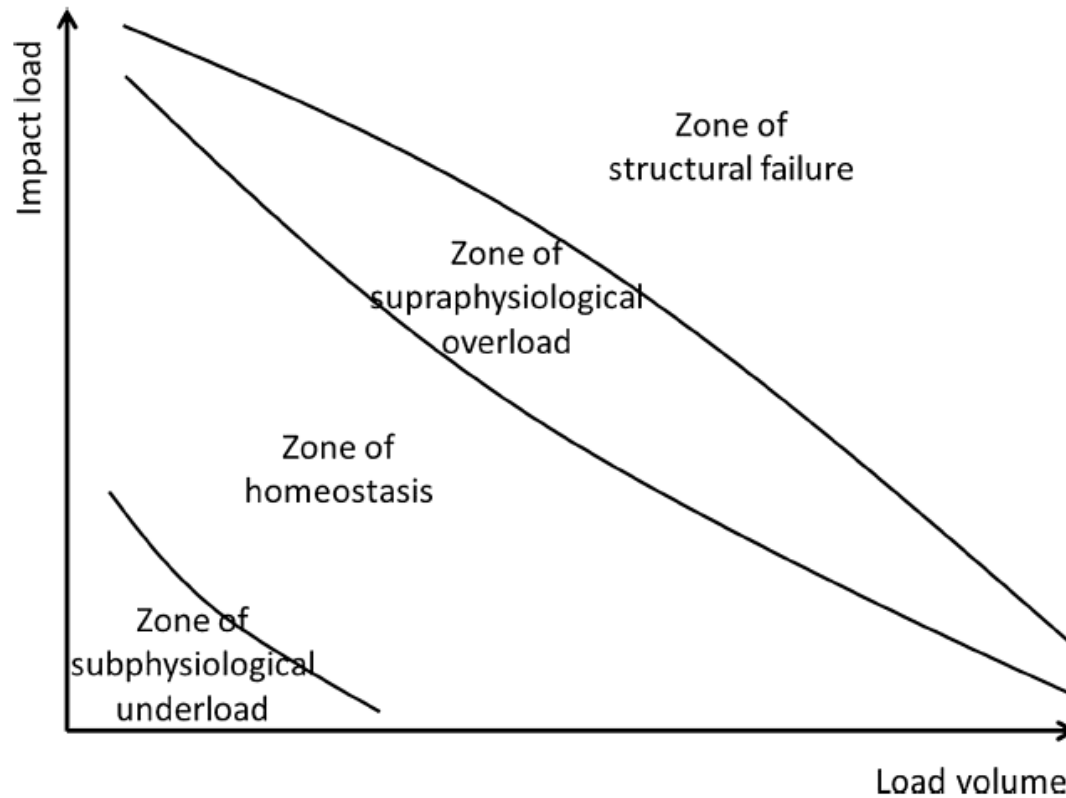
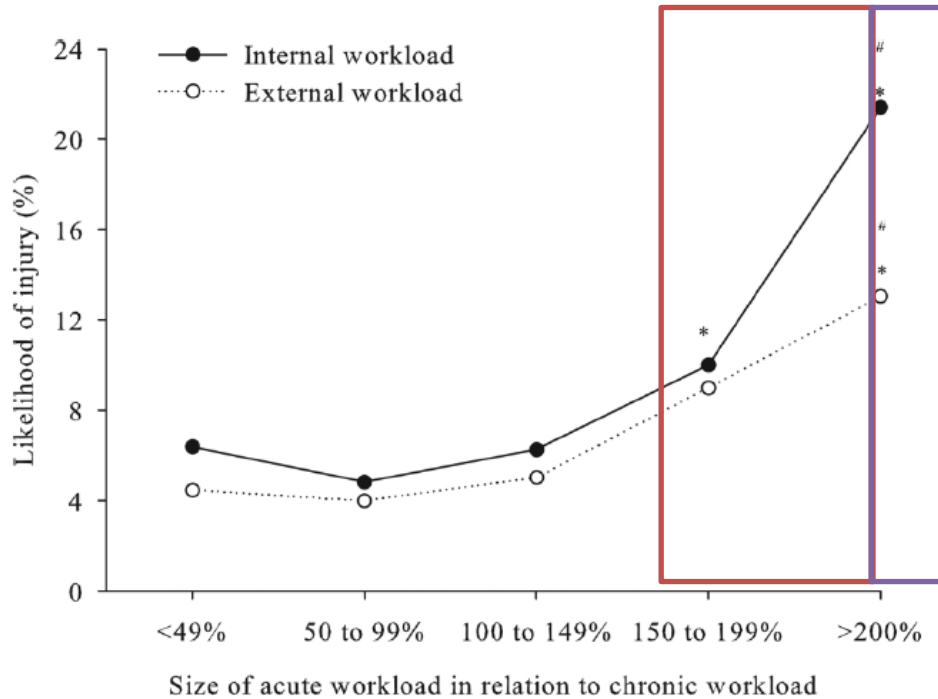


Figure 1 Relationship between structural adaptation and load as modified from Dye’s model for patellofemoral pain (2005).¹ Load volume can be characterised as training volume (frequency, duration, intensity), match frequency, etc. Impact load can be characterised as throwing speed, jump height or other measures of joint load.

Hard to say but...



Significantly different ($p < 0.05$) from <49%.

* Significantly different ($p < 0.05$) from 50 to 99%.

Figure 3 Likelihood of injury in the subsequent week for positive and negative training-stress balance ranges.

Injuries on average occur in our population (across all sports) at ~145 TSB

Illnesses on average occur in our population (across all sports) at ~220 TSB

Case Study Athletics

- Graph of weekly training loads, TSB, injury/illness time stamps and performance
 - ‘money in the bank’ or ‘area under the load curve’ is protective and contributes to building resilience.
 - Sequence of ‘training trough’ preceding ‘TSB spike’ preceding injury/illness is evident on several occasions.
 - The ‘lag period’ post TSB spike over 150% or 200% is anywhere from 1 day to 28 days. In T&F there are several examples of the risk period being around 2-weeks
 - Ceiling and floor risk zones are troughs below 80% TSB and spikes above 150% TSB. These only increase ‘risk’ they do not guarantee injury/illness.
 - Risk periods are commonly seen:
 - Post injury/illness during re-build
 - Post holiday/break, especially post xmas break and post International comp
 - Post travel

- Other graphs included examples of this pattern in T&F in sprint, 4 hurdle and middle distance athletes (including walks). Data is currently being collected for field events.

Questions?