

Wearable Technologies for Injury Reduction...

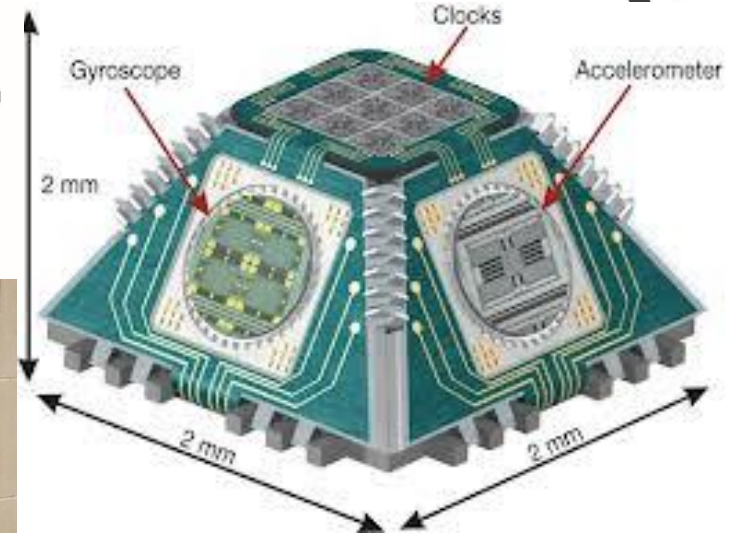
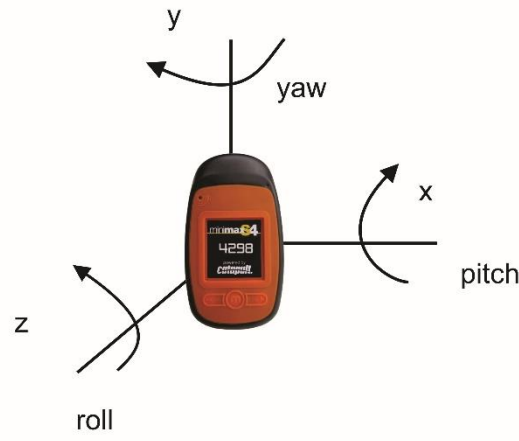
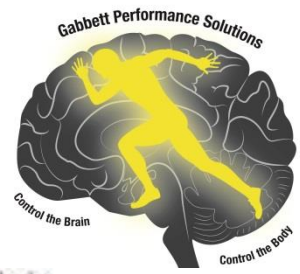
What Can the Workplace Learn from Sport?



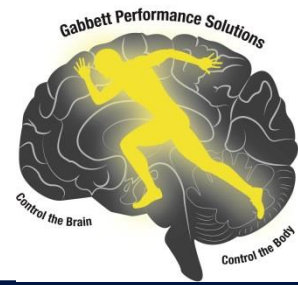
Tim Gabbett, PhD

**Closing the Loop Conference
28th July, 2016**

Overview

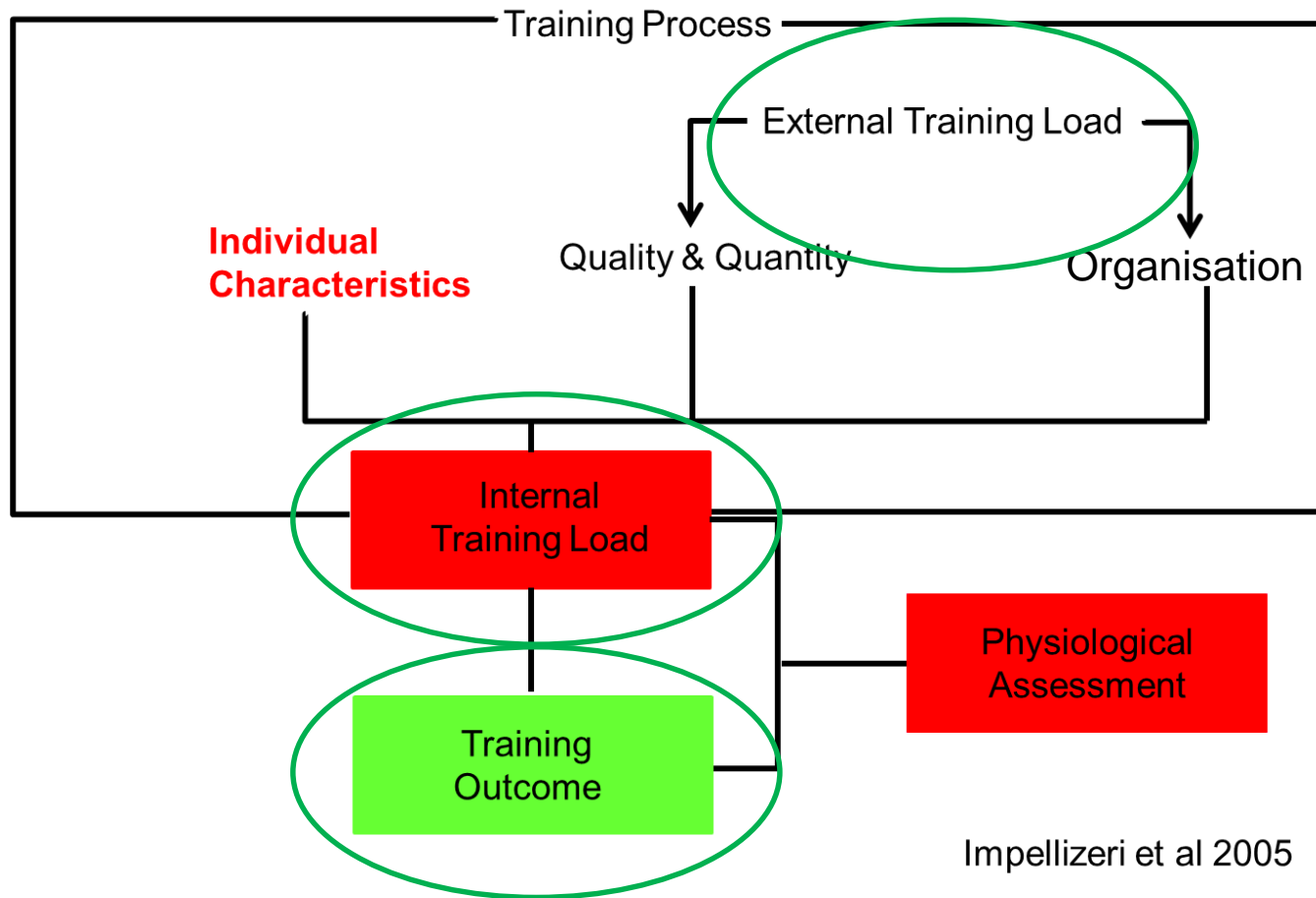
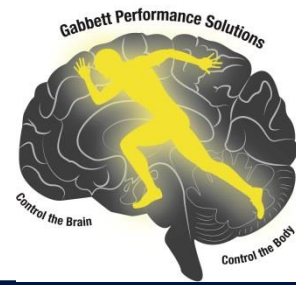


1. Workload-Performance Relationship



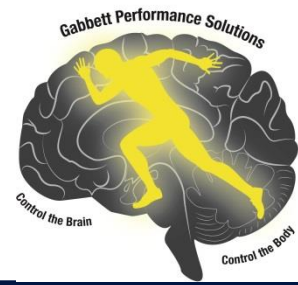
- Determine optimum amount of training required to attain specific performance levels
- Training response reflects difference between a negative function (fatigue) and a positive function (fitness) (Banister, 1975)
- Improvements in performance generally greater with higher training loads
- Negative adaptations to exercise also dose related

Workload Monitoring



Impellizeri et al 2005

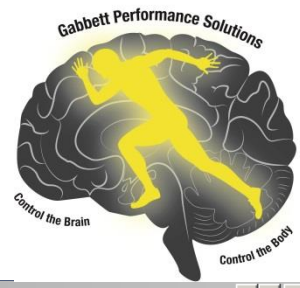
Well-Being/Physical Status



Practical application of physical status results.

Score	Interpretation	Training Application
≥ 81	Healthy	Continue regular training
71-80	1.56 times more likely to sustain an injury	Investigate training loads
≤ 70	1.95 times more likely to sustain an injury	Modify training program

2. Workload and Injury



Logan Plus 4.7.1 - Team Sports : Rugby

Download | Graph Setup | Graphs | Data/Export | Wireless | Strategic Analysis | Diagnostics | Settings | Help | About

View Mode: Team | Player | Alerts | Re-zero At Start Of: Session | Period | Interval | Rotation | View Pass Chain | Stop Period

Qtr 1 - Live | 0 min | Live

Name	Odometer	Meter. / Min	B.3 Dist	B.4 Dist	B3. Mtr/m	B4. Mtr/m	Player Load	P.LD/min (av)
[Redacted]	577	120	46	18	9	3	53	8.00
[Redacted]	510	106	15	25	3	5	59	11.00
[Redacted]	599	124	51	25	10	5	65	13.00
[Redacted]	778	162	76	18	15	3	56	9.84
[Redacted]	658	137	76	25	15	5	64	14.00
[Redacted]	602	125	66	18	13	3	53	15.00
[Redacted]	518	107	30	6	6	1	59	9.84
[Redacted]	640	133	113	7	23	1	68	20.66
[Redacted]	555	115	60	30	12	6	63	20.00
Averages	604	125	59	19	11	3	60	13.48
Totals	5437	1129	533	172	106	32	540	-

0:00 | 0:15

04:47
Game Timer

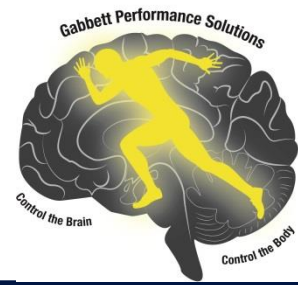
658
Odometer

5
B.3 Efforts

64
Player Load

2
Recent Efforts

Grid: 5m

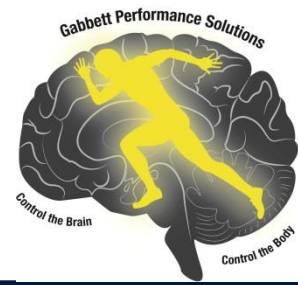


Workload and Injury

Relative risk of soft-tissue injury with high and low running loads in professional football players

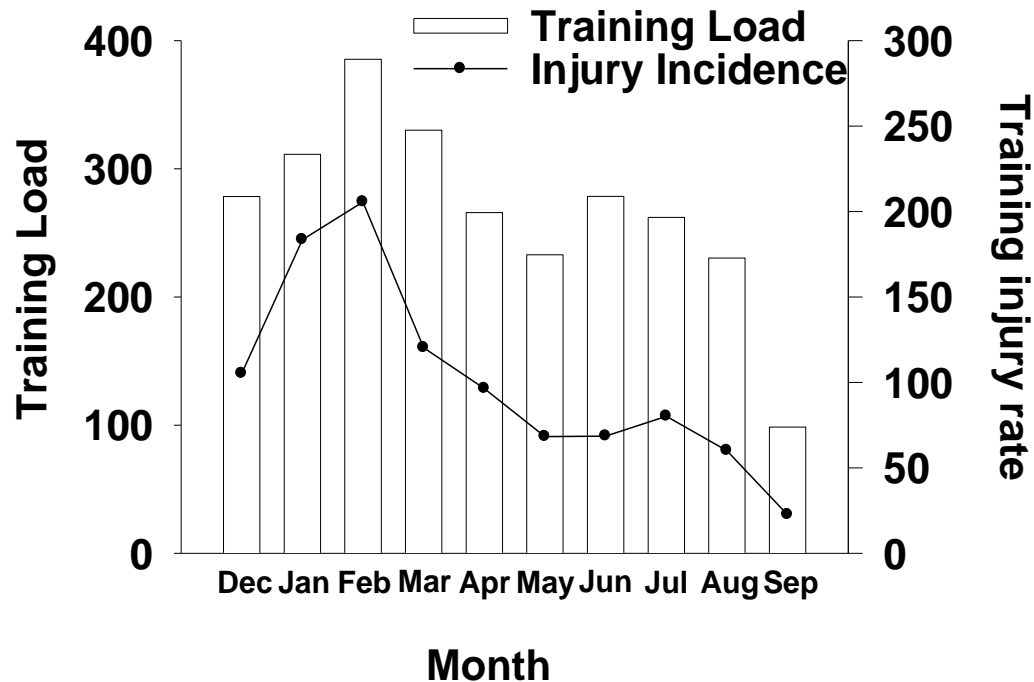
Risk factors	Relative risk (95% CI)		
	Transient	Time lost	Missed matches
Injury history in the previous season (no vs. yes)	1.4 (0.6–2.8)	0.7 (0.4–1.4)	0.9 (0.2–4.1)
Total distance ($\leq 3,910$ vs. $> 3,910$ m)	0.6 (0.3–1.4)	0.5 (0.2–1.1)	1.1 (0.2–6.0)
Relative distance (≤ 60 vs. > 60 m·min ⁻¹)	1.2 (0.5–2.6)	0.8 (0.4–1.6)	0.7 (0.2–2.8)
Very-low intensity (≤ 542 vs. > 542 m)	0.6 (0.2–1.3)	0.4 (0.2–0.9)†	0.4 (0.1–2.8)
Low intensity ($\leq 2,342$ vs. $> 2,342$ m)	0.5 (0.2–1.1)	0.5 (0.2–0.9)†	1.2 (0.2–5.5)
Moderate intensity (≤ 782 vs. > 782 m)	0.4 (0.2–1.1)	0.5 (0.2–1.0)	0.5 (0.1–2.3)
High intensity (≤ 175 vs. > 175 m)	0.8 (0.2–3.1)	0.9 (0.3–3.4)	2.9 (0.1–16.5)
Very-high intensity (≤ 9 vs. > 9 m)	2.7 (1.2–6.5)†	0.7 (0.3–1.6)	0.6 (0.1–3.1)
Total high intensity (≤ 190 vs. > 190 m)	0.5 (0.1–2.1)	1.8 (0.4–7.4)	0.7 (0.1–30.6)
Mild acceleration (≤ 186 vs. > 186 m)	0.2 (0.1–0.4)‡	0.5 (0.2–1.1)	1.5 (0.3–8.6)
Moderate acceleration (≤ 217 vs. > 217 m)	0.3 (0.1–0.6)‡	0.4 (0.2–0.9)†	1.4 (0.3–7.5)
Maximum acceleration (≤ 143 vs. > 143 m)	0.4 (0.2–0.8)†	0.5 (0.2–0.9)†	1.8 (0.4–8.8)
Repeated high-intensity effort bouts (≤ 3 bouts vs. > 3 bouts)	0.9 (0.4–2.0)	1.6 (0.8–3.3)	1.0 (0.2–4.4)

Gabbett and Ullah (2012). *J Strength Cond Res*, 26:953-960.



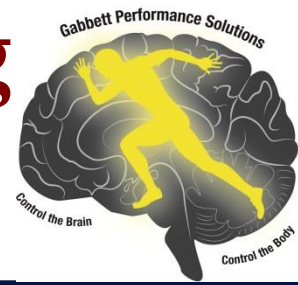
Workload and Injury

Relationship between training load and injury rate.

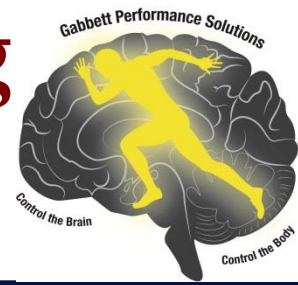


Gabbett (2004). *J Sports Sci*, 22:409-417.

Automated Bowling Counts Using Wearable Microtechnology



Automated Bowling Counts Using Wearable Microtechnology



Training

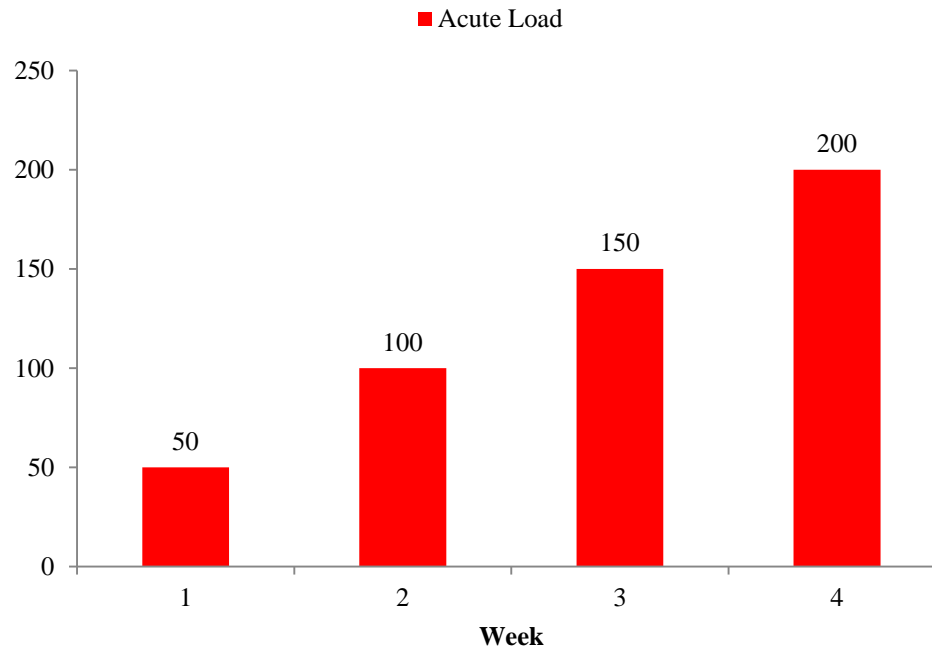
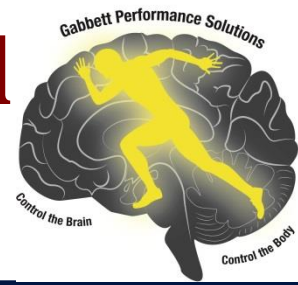
		Ball Bowled during training (as determined by direct bowling count)	
		Ball Bowled	Ball Not Bowled
Automatic detection of ball bowled during training	Bowling Event Automatically Detected	True Positive = 285	False Positive = 3
	Bowling Event Not Detected		
		Sensitivity = 99.0%	Specificity = 98.1%

Competition

		(as determined by direct bowling count)	
		Ball Bowled	Ball Not Bowled
Automatic detection of ball bowled during competition	Bowling Event Automatically Detected	True Positive = 213	False Positive = 34
	Bowling Event Not Detected		
		Sensitivity = 99.5%	Specificity = 74.0 %

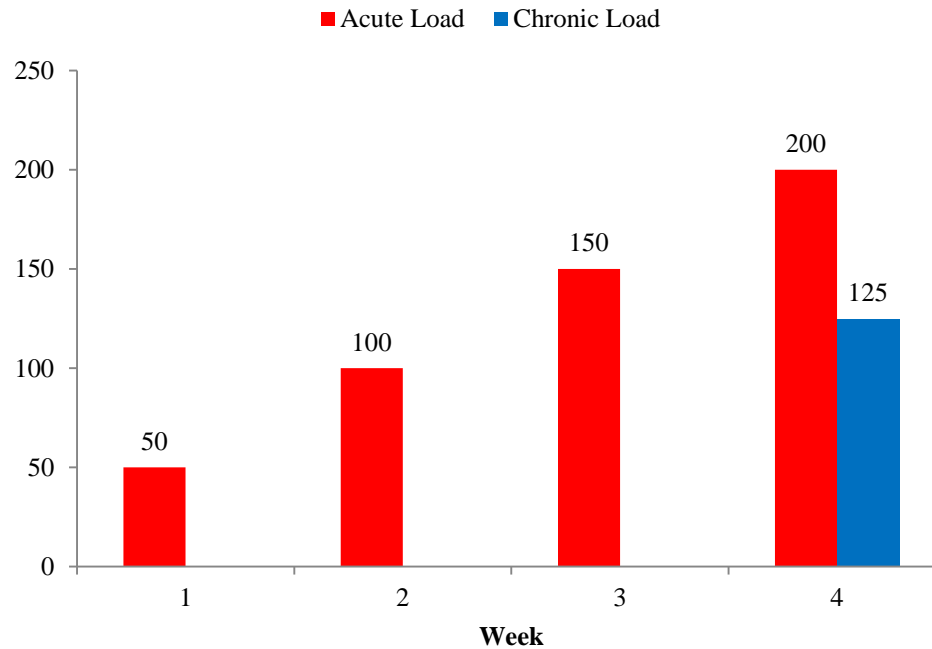
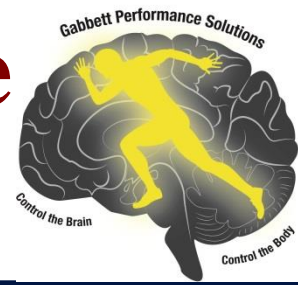
McNamara, Gabbett et al. (2015). *Int. J. Sports. Physiol. Perform.*, 10:71-75.

3. Is There a Better Way to Model the Workload-Injury Relationship?



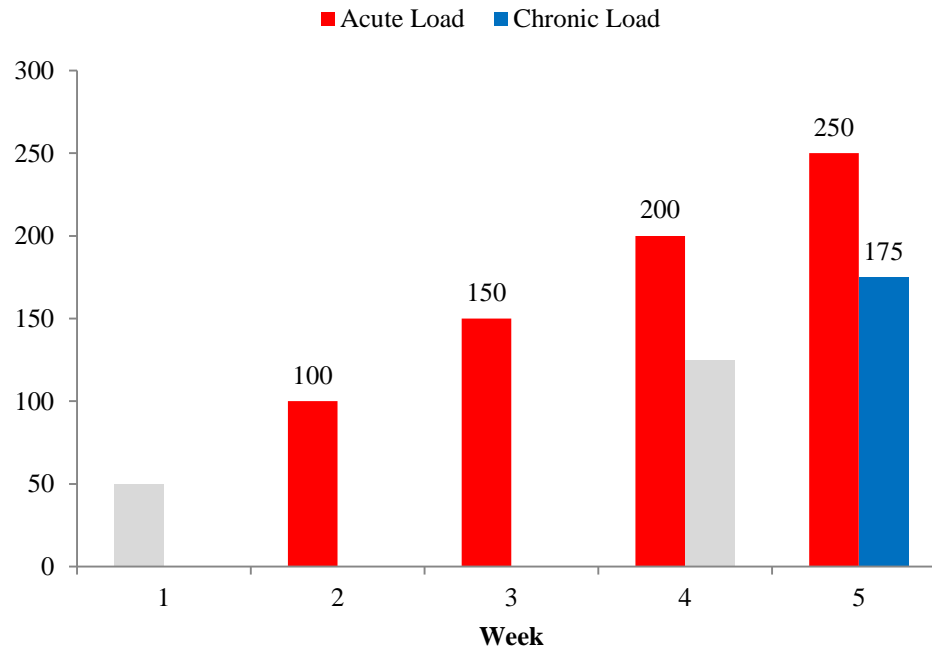
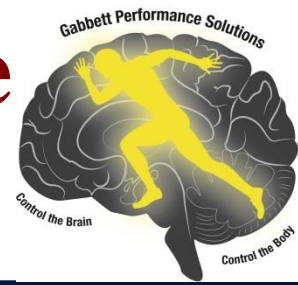
Hulin, Gabbett, et al. (2014). *Br J Sports Med*, 48:708-712.

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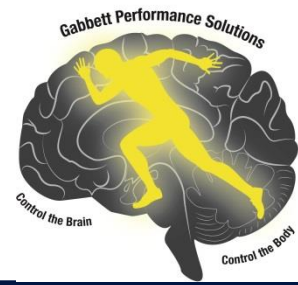
Hulin, Gabbett, et al. (2014). *Br J Sports Med*, 48:708-712.

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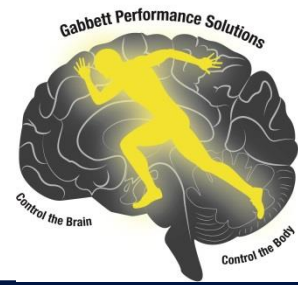
Acute:Chronic Workload Ratio



$$\text{Acute/Chronic} = \text{Acute:Chronic Workload Ratio}$$
$$1000/4000 = 0.25$$

Hulin, Gabbett, et al. (2014). *Br J Sports Med*, 48:708-712.

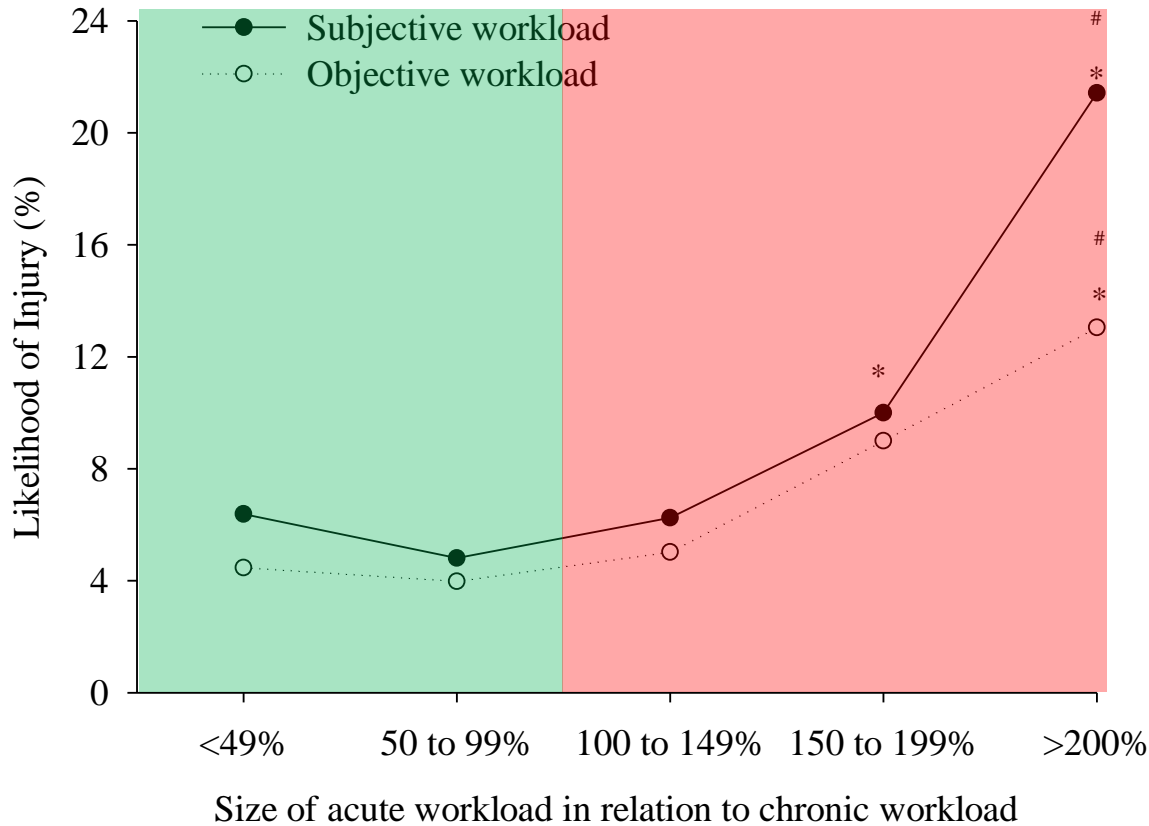
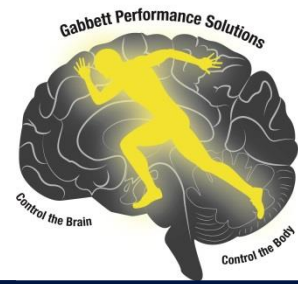
Acute:Chronic Workload Ratio



$$\text{Acute/Chronic} = \text{Acute:Chronic Workload Ratio}$$
$$4000/1000 = 4.0$$

Hulin, Gabbett, et al. (2014). *Br J Sports Med*, 48:708-712.

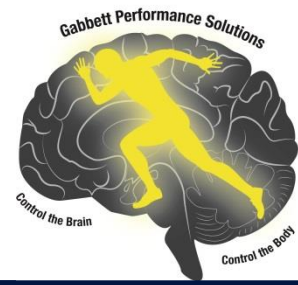
Risk of Injury



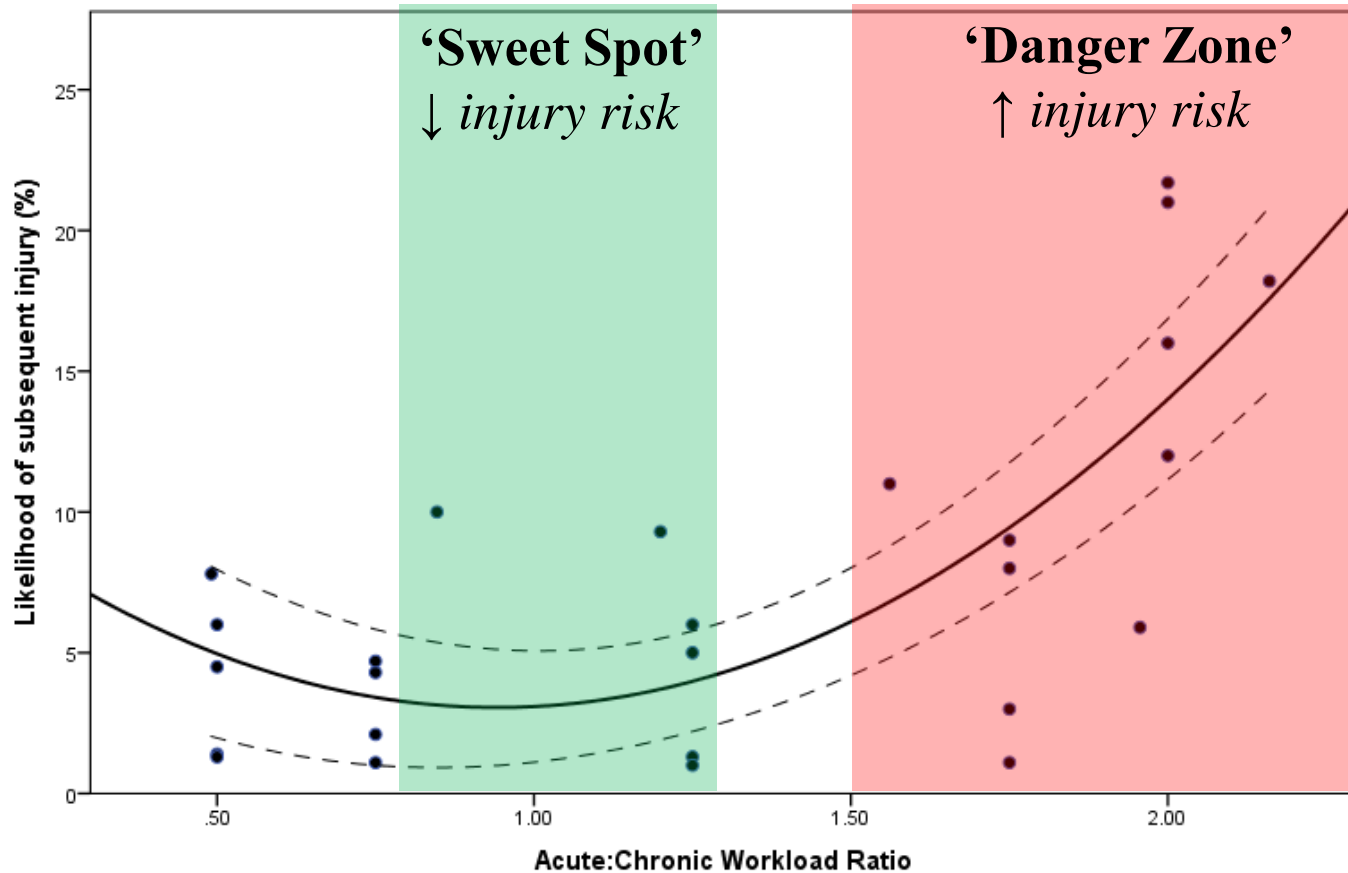
Relative Risk

With an A:C workload ratio >1.5 injury risk is double (RR=2.2; 2.1)

Hulin, Gabbett, et al. (2014). *Br J Sports Med*, 48:708-712.

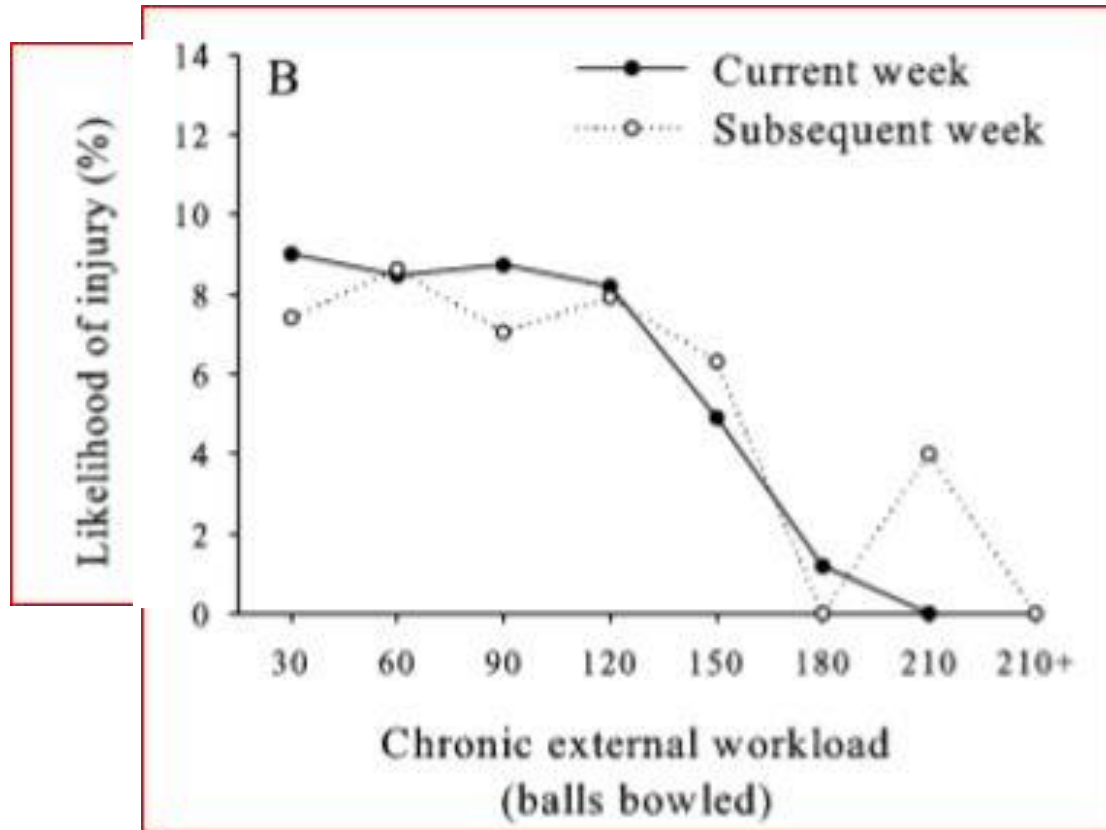
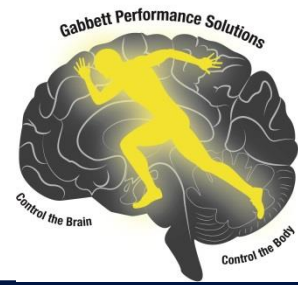


Workload Monitoring to Manage Risk



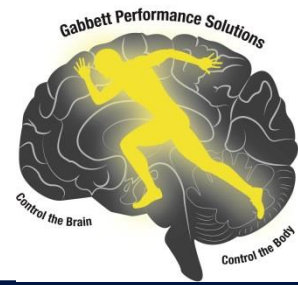
Blanch & Gabbett. (2016). *Br. J. Sports. Med.*, 50:471-475.

What About High Chronic Loads?



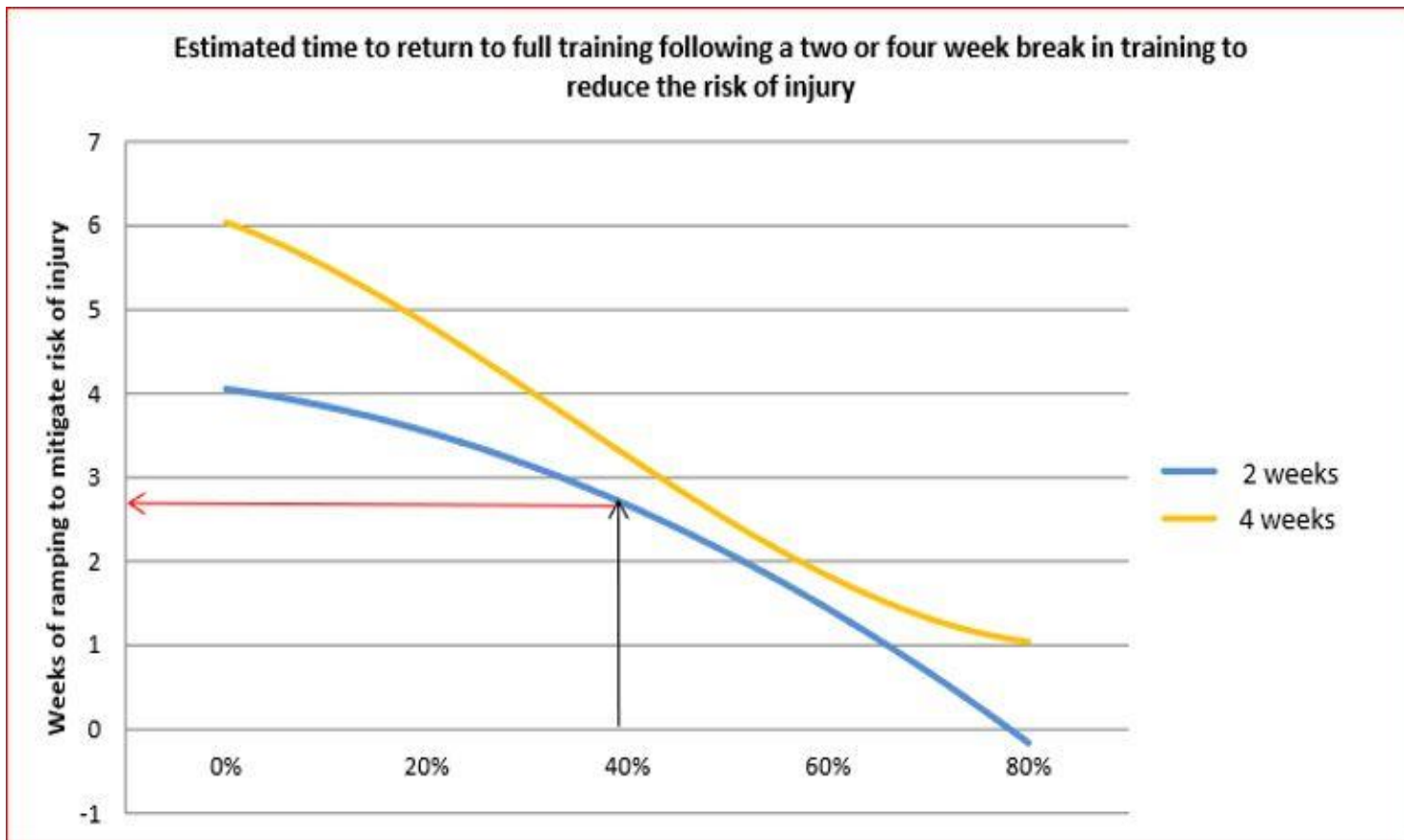
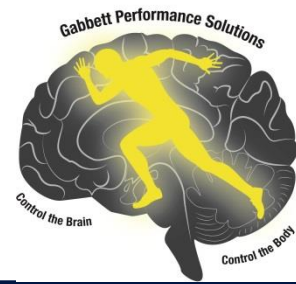
Hulin, Gabbett, et al. (2014). *Br J Sports Med*, 48:708-712.

Practical Application of Data...



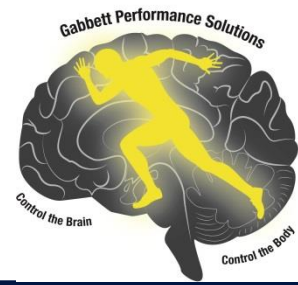
1. Return to Training following Off-Season Break
2. Return to Train, Play, and 'Compete' Plans
3. Forward Prediction of Training Loads to Minimise "Spikes"

Returning to Training Following Off-Season Break



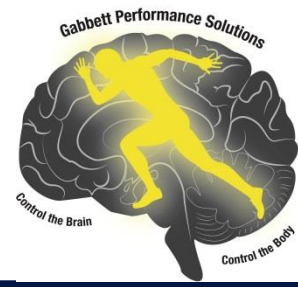
Purdam et al. (2015). *Australian Institute of Sport*, white paper.

Acute:Chronic Workload & Injury Risk



Chronic Workload	Acute Workload							
	60	70	80	90	100	110	120	
110	4.7	4.1	3.6	3.4	3.2	3.3	3.5	
100	4.3	3.7	3.4	3.3	3.3	3.6	4.0	
90	3.9	3.5	3.3	3.3	3.6	4.2	4.9	
80	3.5	3.3	3.3	3.7	4.3	5.3	6.6	
70	3.3	3.3	3.7	4.6	5.8	7.5	9.5	
60	3.3	3.8	4.9	6.6	8.8	11.6	14.9	
50	4.0	5.5	7.9	11.0	14.9	19.6	25.1	
40	6.6	10.1	14.9	20.9	28.2	36.7	46.5	
30	14.9	23.2	33.7	46.5	61.4	78.6	98.0	

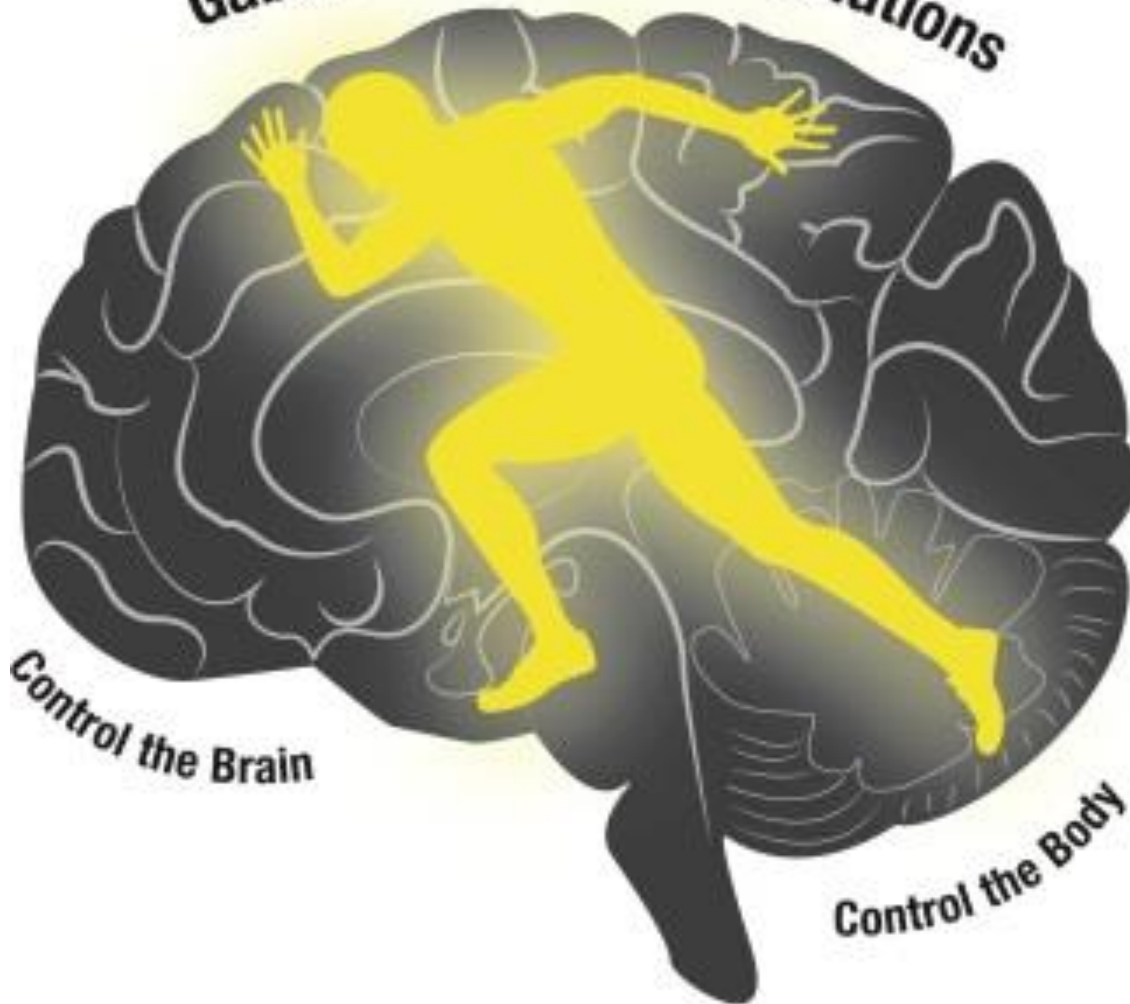
Blanch & Gabbett. (2016). *Br. J. Sports. Med.*, 50:471-475.



Practical Applications

- Wearable technologies offer a way to track the *external* and *internal* workloads of employees in the workplace
- *There are privacy issues...*
- In *sport*, monitoring workloads, *including the workload that athletes are prepared for*, offers a best practice approach to the long-term reduction of injuries
- Monitoring the *acute:chronic workload ratio* will likely be useful for monitoring employees in the workplace

Gabbett Performance Solutions



www.gabbettperformance.com



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