Detection and Prevention of Overtraining in Athletes

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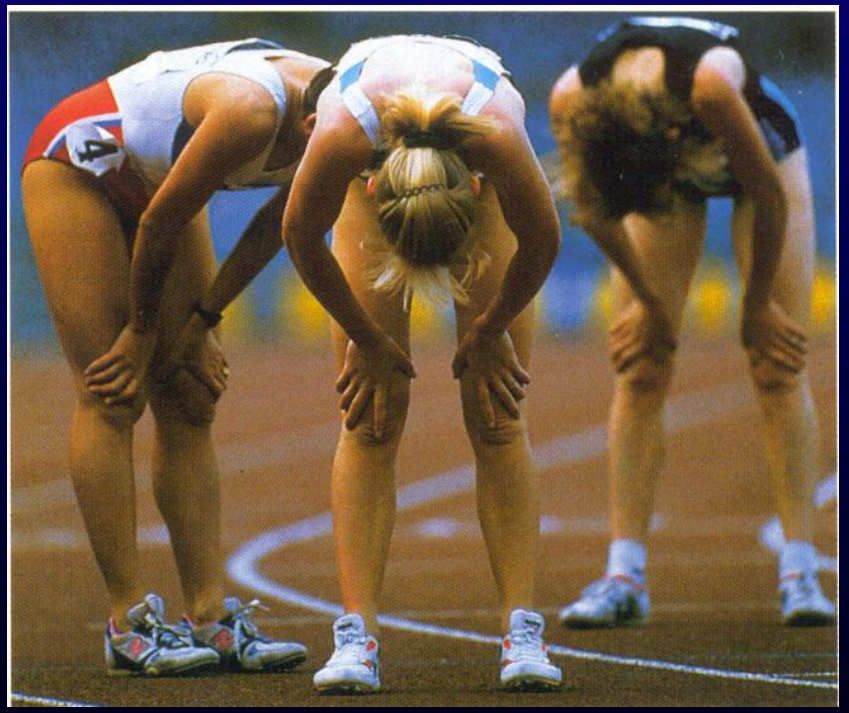


Hellenic Society of Biochemistry and Physiology of Exercise, Athens, 12-13 October 2012

Overtraining lecture summary

- Definition of overtraining
- Symptoms & causes of overtraining
- Diagnosis of overtraining
- Evaluation of markers
- Prevention of overtraining

Overtraining – ECSS-ACSM Consensus

Prevention, diagnosis and treatment of the Overtraining Syndrome (2012)
Joint consensus statement of the European College of Sport Science (ECSS) and the American College of Sports Medicine (ACSM)

Romain Meeusen, Belgium (chair)
Martine Duclos, France
Carl Foster, USA
Andrew Fry, USA
Michael Gleeson, UK
David Nieman, USA
John Raglin, USA
Gerard Rietjens, The Netherlands
Jürgen Steinacker, Germany
Axel Urhausen, Luxembourg

Meeusen et al (2006) Eur J Sport Sci 6(1): 1-14

Meeusen et al (2012) Eur J Sport Sci & Med Sci Sports Exerc

What is overtraining syndrome?

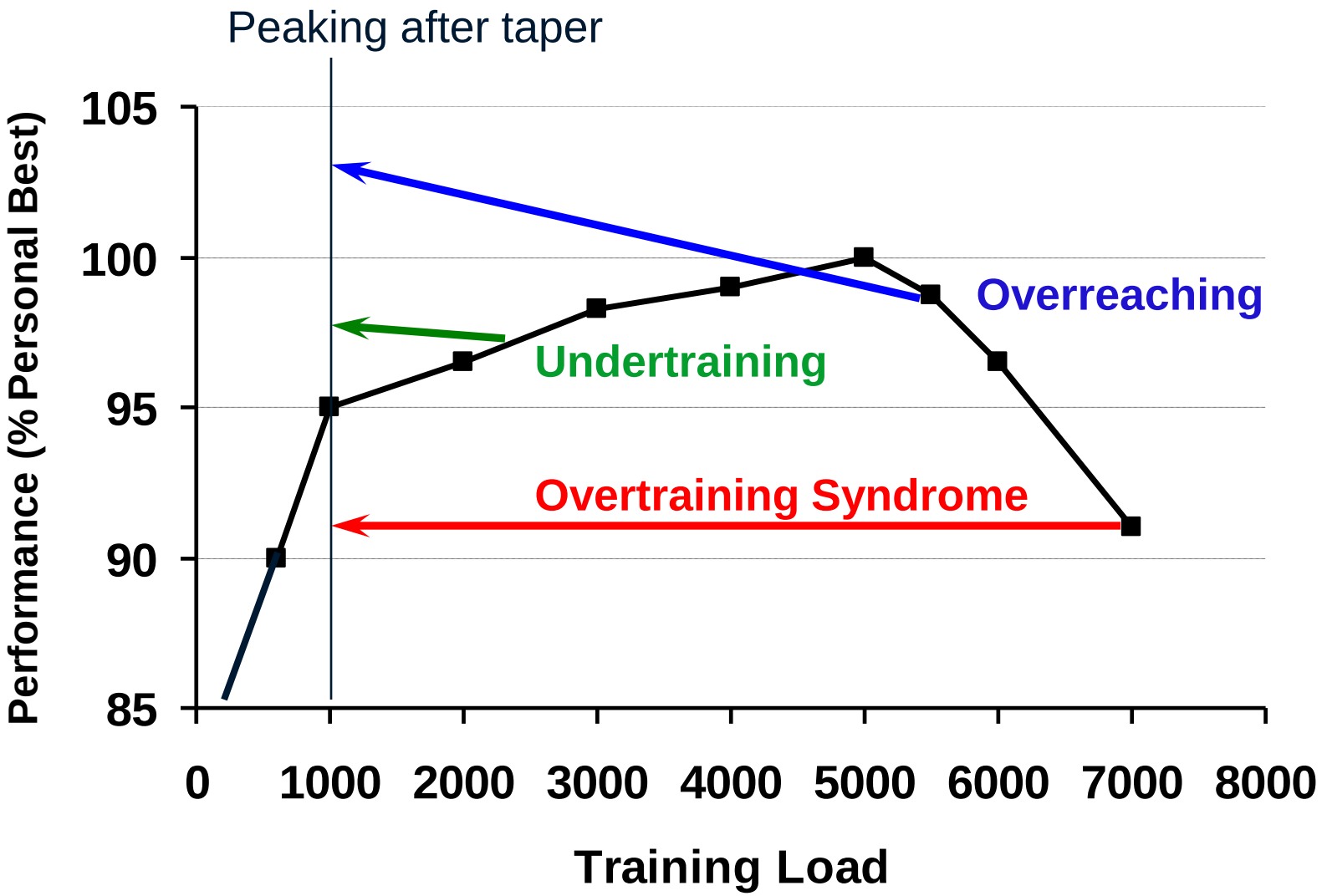
- Burnout
- Overwork
- Staleness
- Chronic fatigue
- Unexplained under-performance

Definition of overtraining

Overtraining: An accumulation of training-related stress resulting in persisting decrement in performance capacity lasting weeks or months

Overreaching: An accumulation of training-related stress resulting in temporary decrement in performance capacity lasting less than 2 weeks

Relationship between Training Load and Performance



Overtrained or fatigued?

Possible causes of under-performance:

- Acute fatigue after exercise
- Glycogen depletion (24-48 hrs to recover)
- Delayed onset muscle soreness (2-3 days)
- Illness (e.g. viral infection)
- Allergy
- Anaemia
- Vitamin D deficiency?

Alternative definition (2000)

Unexplained Under-performance Syndrome (UPS):

A persistent unexplained performance deficit (recognised and agreed by coach and athlete) despite two weeks of relative rest

Budgett et al (2000) Br J Sports Med 34: 67-68

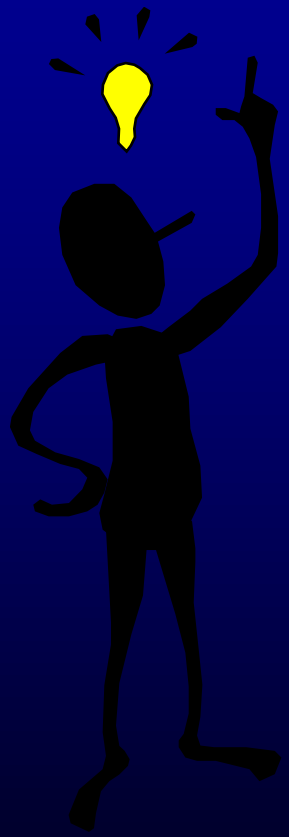
Symptoms of Overtraining

ALWAYS:
Fatigue and unexpected sense of effort during training and under-performance in competition

ALSO:

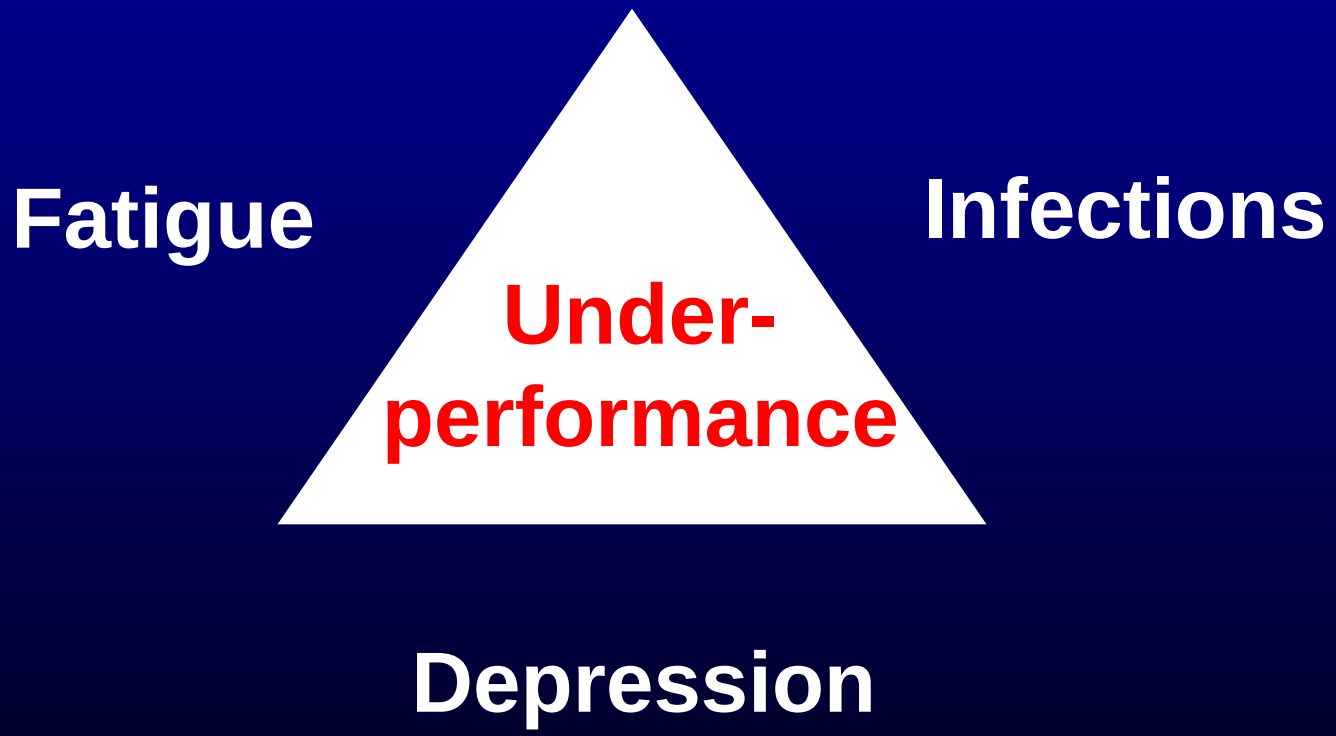
- History of heavy training and competition
- Frequent minor infections
- Heavy/stiff/sore muscles
- Mood disturbance: irritability, depression
- Disturbed sleep
- Loss of energy/drive/appetite

No.1 marker of overtraining in male athletes



Loss of sexual appetite

Major signs of overtraining



Diagnosis of overtraining

Previous high training load; underperformance → OTS?
Key symptoms present despite adequate recovery time?
Persistent fatigue/underperformance lasting > 4 weeks

Rule out diseases that could explain underperformance
Viral (EBV, Hepatitis, HIV); Bacterial (Borreliosis, Streptococcal); Allergic/Inflammatory; Other (Diabetes, Hyperthyroidism, Anaemia)

Performance changes defined
Max Performance (e.g. TTE, TT, Isokinetic power) reduced >10%
Reduced sport-specific performance. Altered hormonal responses

Possible provoking conditions checked
Recent illness, psycho-social factors, nutritional disorders, extreme environments, increased training load

→ OTS is likely

Causes of overtraining

- Excessive number of competitive events
- Limited recovery time
- Training too hard for too long
- Inadequate diet/negative energy balance
- Competing/training with injuries/infections
- Psychological stress

Maladaptation to excessive stress – probably in response to a combination of stressors

Training and hormones

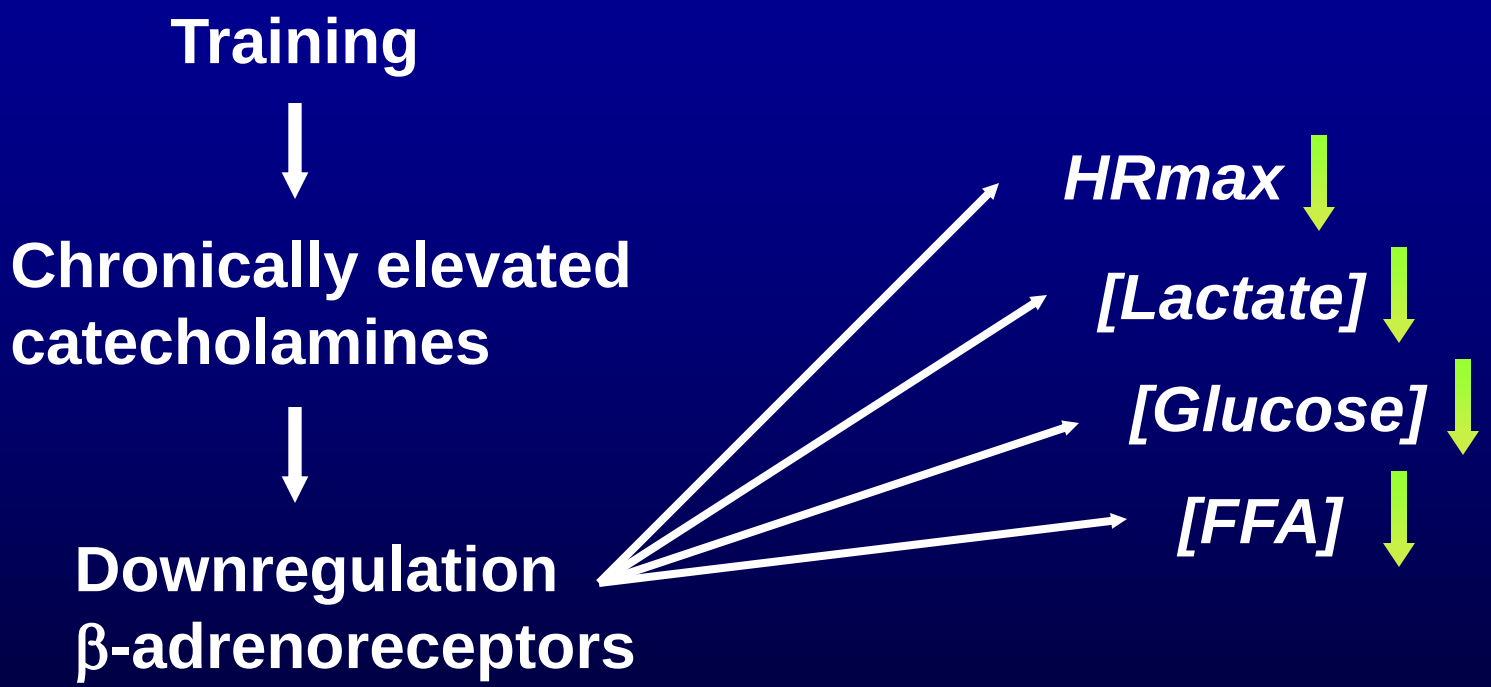
- **Acute bouts of exercise and stress elevate stress hormone secretion**
- **Excessive training (stress) may lead to a hormonal imbalance:**

Reduced adrenal hormone responses to exercise and tissue insensitivity to catecholamines

Disturbance of pituitary hormone secretion

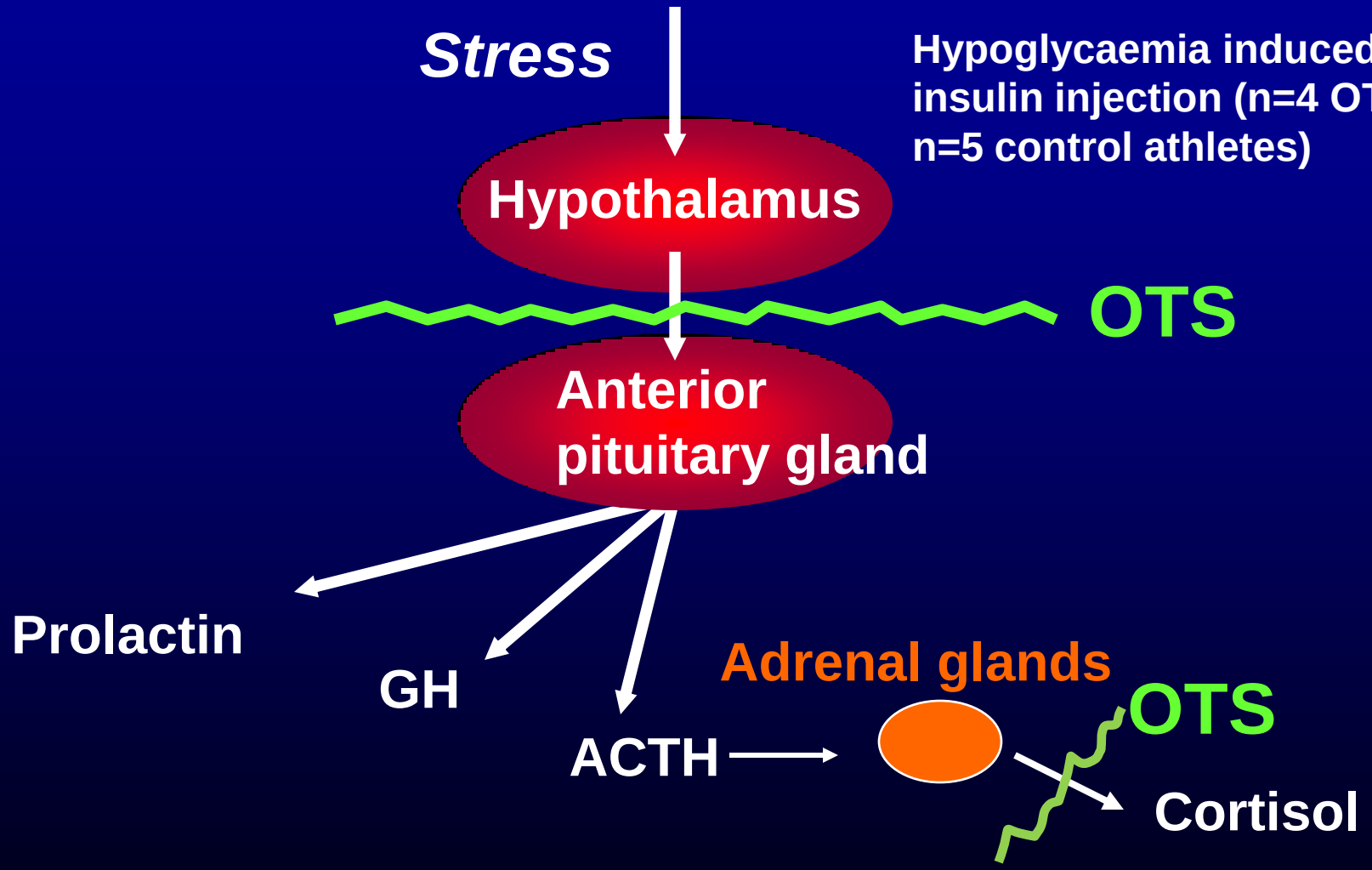
Causing "parasympathetic" type of overtraining syndrome

Increased training



Hypothalamic dysfunction?

Barron et al Endocrinol Metab 60: 803-806, 1985



Hypoglycaemia induced by insulin injection (n=4 OTS *vs* n=5 control athletes)

Conclusions

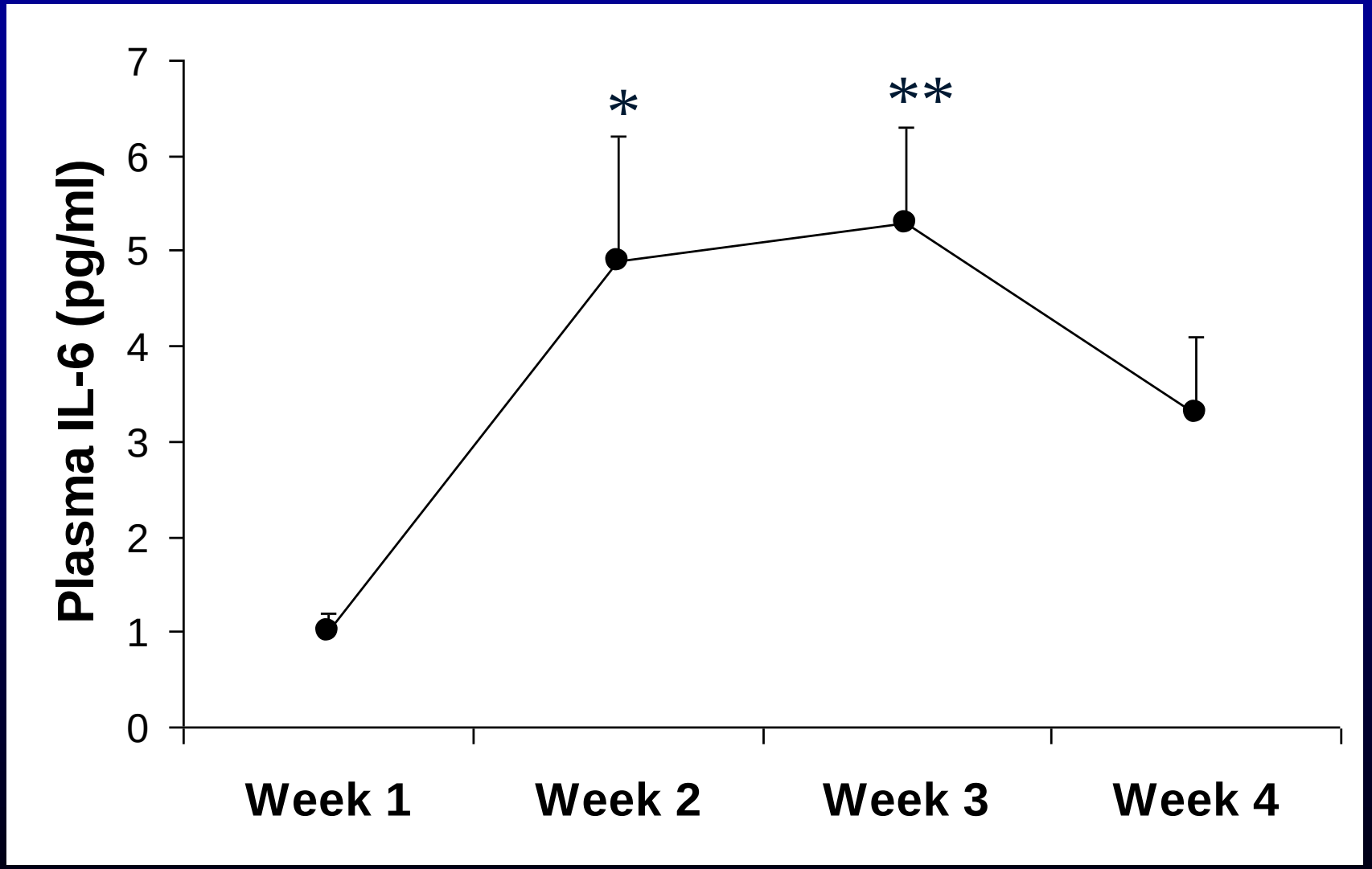
- Overtraining may result in ***lower submaximal and maximal lactate*** concentrations during exercise
- This may be due to ***decreased intrinsic activity*** of the ***sympathetic nervous*** system rather than muscle glycogen depletion
- Overtraining is associated with reduced pituitary hormone and cortisol responses to stress
- Other hormonal and neurotransmitter changes may be responsible for some of the symptoms of UPS

Cytokine hypothesis of overtraining

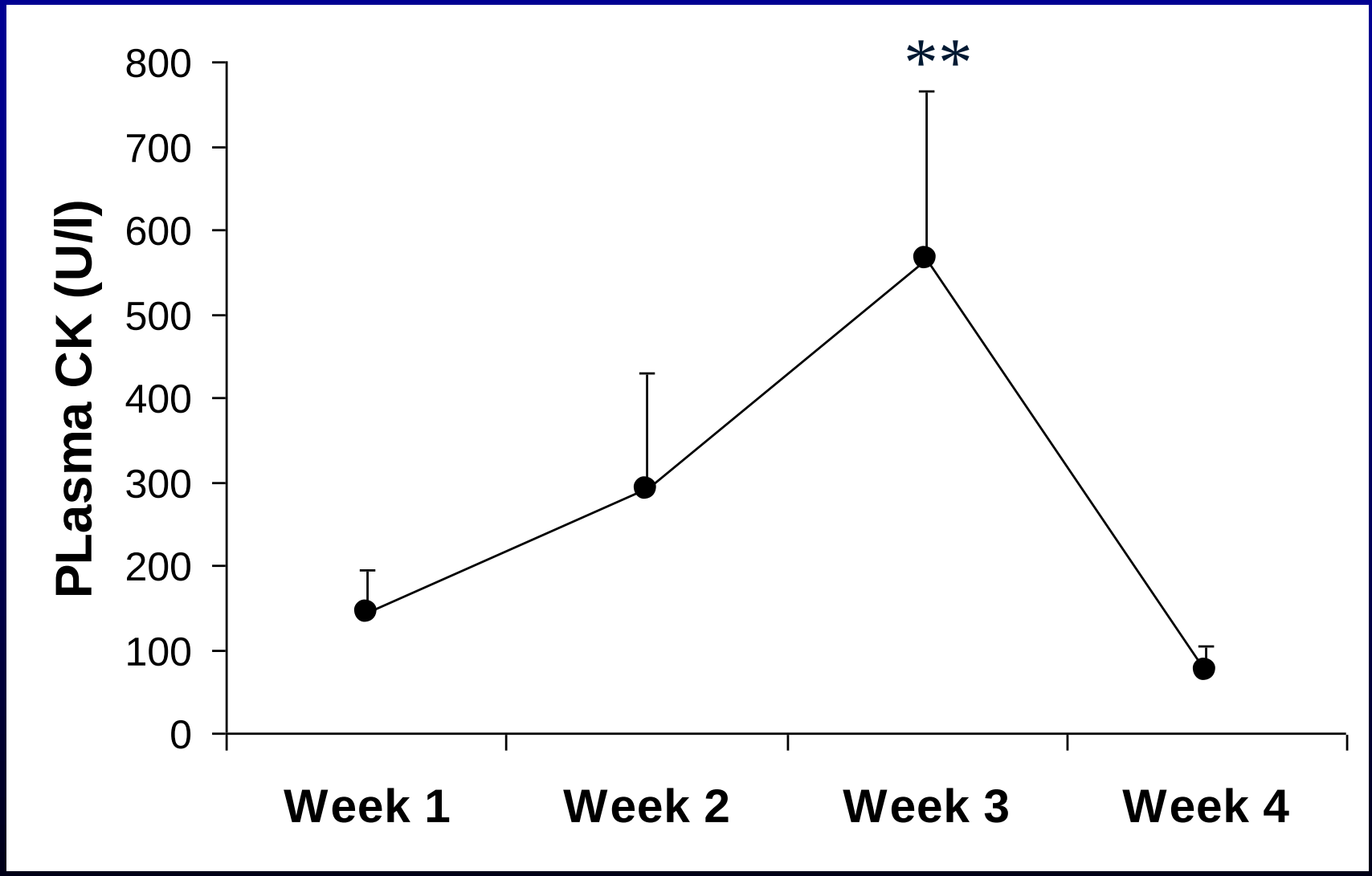
According to the cytokine hypothesis of overtraining (OT), high volume/intensity training, with insufficient rest, will produce tissue trauma stimulating monocytes to produce large quantities of proinflammatory cytokines including IL-6 and TNF-α (L Smith, 2000, *Med Sci Sports Exerc* 32: 317-331). These then induce mood and behavior changes (e.g. fatigue, depression) and immune function changes

However, no change in resting plasma concentration of IL-6 or TNF was detected after 2 weeks of overtraining in cyclists (Gleeson *et al.* 2001, *Med Sci Sports Exerc* 33(5): Suppl. ISEI, 44)

Robson-Ansley et al 2007 Elevated plasma IL-6 levels in trained male triathletes following an acute period of intense interval running training. *Eur J Appl Physiol* 99: 353-360



Robson-Ansley et al 2007 Elevated plasma IL-6 levels in trained male triathletes following an acute period of intense interval running training. *Eur J Appl Physiol* 99: 353-360



Main LC et al. 2010. Relationship between inflammatory cytokines and self-report measures of training overload. *Res Sports Med* 18(2): 127-139

N=8 elite male rowers monitored during training (24 h/week) for 8 weeks prior to the 2007 Rowing World Championships. Self-report measures of overtraining and plasma cytokines (IL-1β, IL-6, IL-8, IL-10, IL-12p70 and TNF-α) were assessed every 2 weeks.

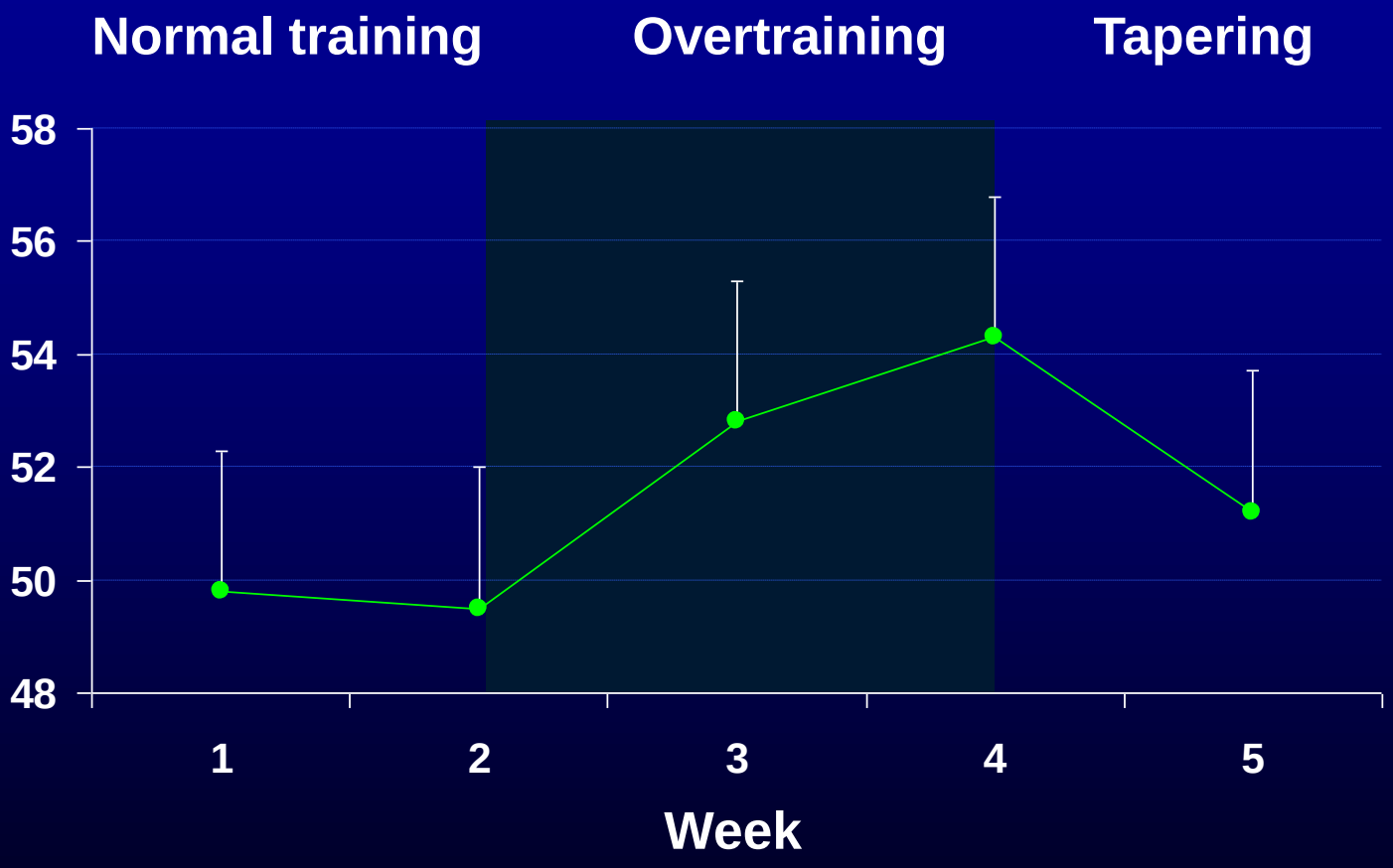
Levels of plasma pro-inflammatory cytokines IL-1β and TNF-α were significantly associated ($p<0.05$*) with measures of depressed mood, sleep disturbances, and stress. Similarly, IL-6 was significantly associated (*$p\leq0.01$*) with depressed mood, sleep disturbances, and fatigue.*

Practical tools to monitor training adaptation

Tool	Description	Evidence/Limitations	Rating
Diaries, questionnaires, sleep and resting HR			
Diaries, POMS, DALDA, TDS, TQR and RESTQ-Sport. Sleep and HR_{rest}. **Psychomotor speed tests**	Self-report questionnaires for monitoring mood, exertion, life demands and recovery. Simple monitors (e.g. Actigraph) can assess sleep. Sleeping HR elevated in overreaching	Limited on predicting progression to OTS. Issues with compliance. Unclear whether the quantity and quality of sleep identifies progression into OTS.	●●●○○
Training load			
Distance, time, speed, power etc. HR zones, TRIMP, session RPE.	Some simple, yet descriptive, tools now easily monitored with GPS/power meters etc. HR, TRIMP and session RPE provide more specific information about training stress.	Training load assessment can be subjective (e.g. session RPE). Nevertheless, session RPE may be useful when HR monitors are unavailable. TRIMP provides information beyond HR alone but has limited utility for exercise above the anaerobic threshold.	●●●○○
Exercise and performance testing			
Sub-maximal and maximal exercise testing.	Assess HR, blood lactate and neuroendocrine responses (e.g. blood ACTH, cortisol) to exercise test.	Maximal HR and blood lactate are reduced in OTS. Blunting of cortisol response to exercise. Utility of lactate and neuroendocrine responses to exercise to track progression into (and recovery from) OTS is mixed.	●●○○○
Exercise performance tests.	Exercise performance tests are essential to diagnose OTS.	Useful to identify recovery from intensified training. Less useful to confirm recovery from OTS as fitness will likely decrease during OTS. Exercise performance tests should be sport specific.	●●●●○

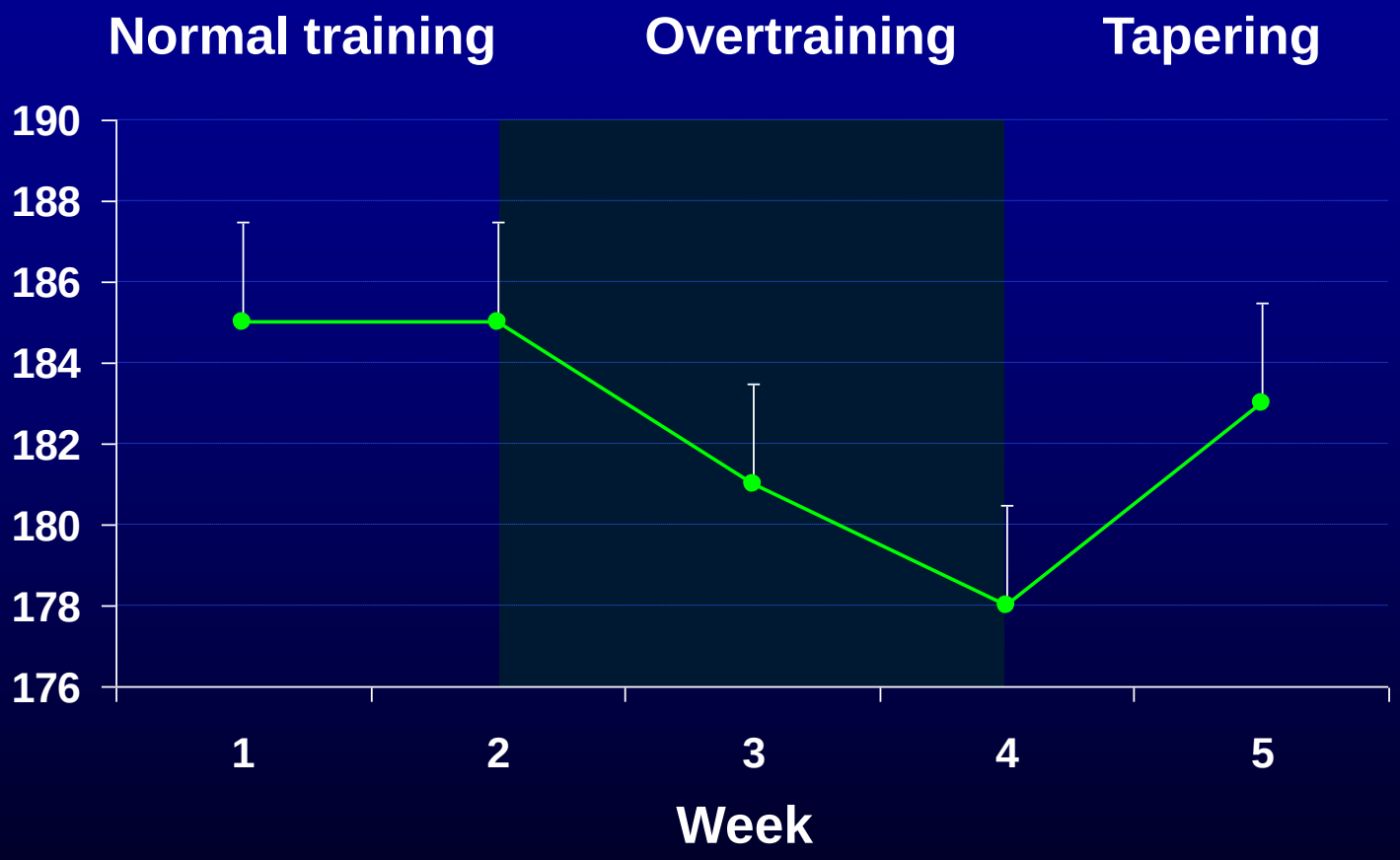
HR during sleep

Jeukendrup et al IJSM 13: 534-541, 1992



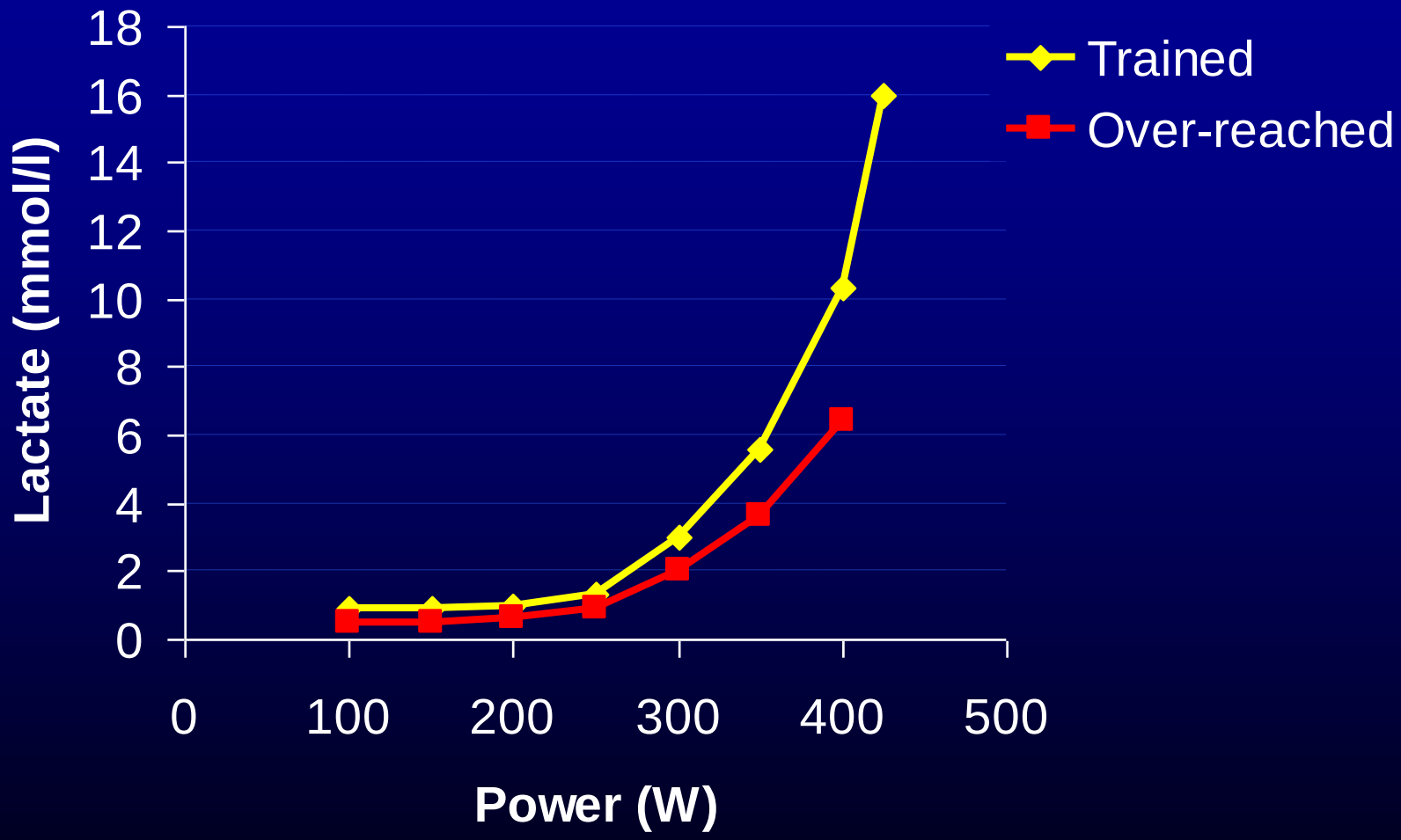
HRmax

Jeukendrup et al IJSM 13: 534-541, 1992



Decreased blood lactate response to incremental exercise

Jeukendrup et al IJSM 13: 534-541, 1992



Biochemical and haematological tools to monitor training adaptation

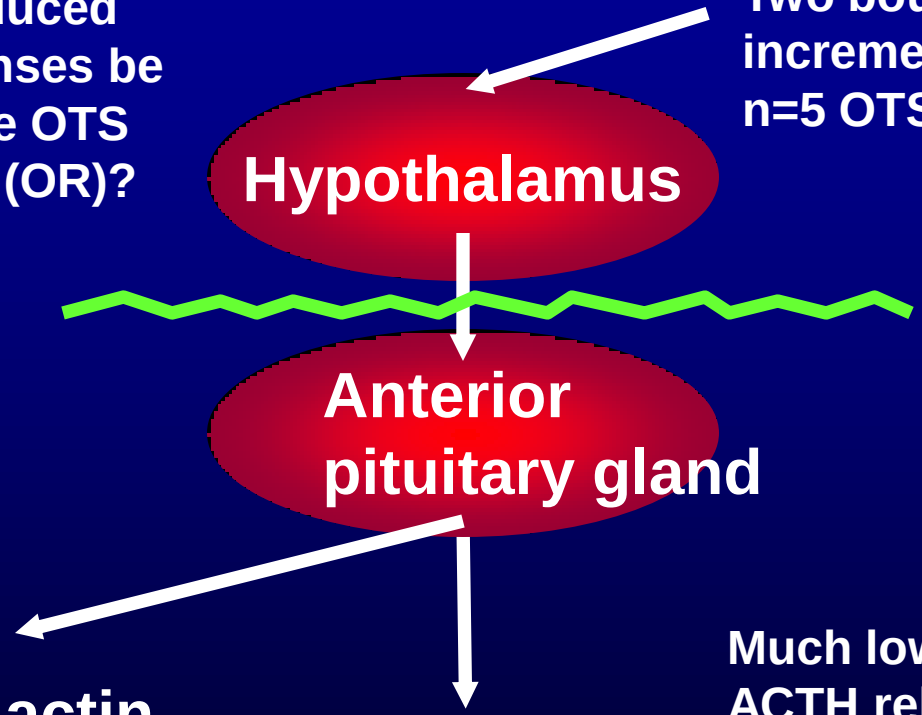
Tool	Description	Evidence/Limitations	Rating
Biochemical			
Free testosterone: cortisol ratio	Indicator of anabolic/catabolic balance. Can be assessed in both blood and saliva.	May indicate response to training but cannot identify OTS. A low free T:C ratio (<30%) indicates over-reaching. Unclear how these changes relate to performance. Costly and time consuming.	●●○○○
Plasma glutamine	Non-essential amino acid. Important fuel for immune cells. Ratio to glutamate may indicate training stress.	Plasma glutamine decreases in response to intensified training, over-reaching and OTS. Ratio to glutamate has been shown to indicate training intolerance. Requires blood sample. Costly and time consuming.	●●●○○
Blood CK and CRP	Indicators of muscle damage and inflammation.	Not suitable to indicate training adaptation, over-reaching or OTS. Some utility to exclude other explanations for underperformance. Requires blood sample. Costly and time consuming.	●○○○○
Serum iron, ferritin and transferrin	Indicators of inflammation and chronic recovery. Iron deficiency can lead to anaemia.	May be reduced in chronically exercising individuals, particularly during high intensity training. Decrease may negatively affect performance. Requires blood sample. Costly and time consuming.	●●○○○
Haematological			
Red blood cell count, haemoglobin and haematocrit. Differential white blood cell count	Standard clinical laboratory tests.	Normal clinical ranges established. Cannot detect over-reaching or OTS. Useful for determining overall health status. Can be performed on finger prick rather than venous blood sample.	●●○○○

Exercise test to diagnose OTS

Meeusen et al 2010 Br J Sports Med 44: 642-648

Can exercise-induced hormonal responses be used to diagnose OTS *vs* overreaching (OR)?

Two bout maximal incremental exercise test in n=5 OTS *vs* n=5 OR athletes

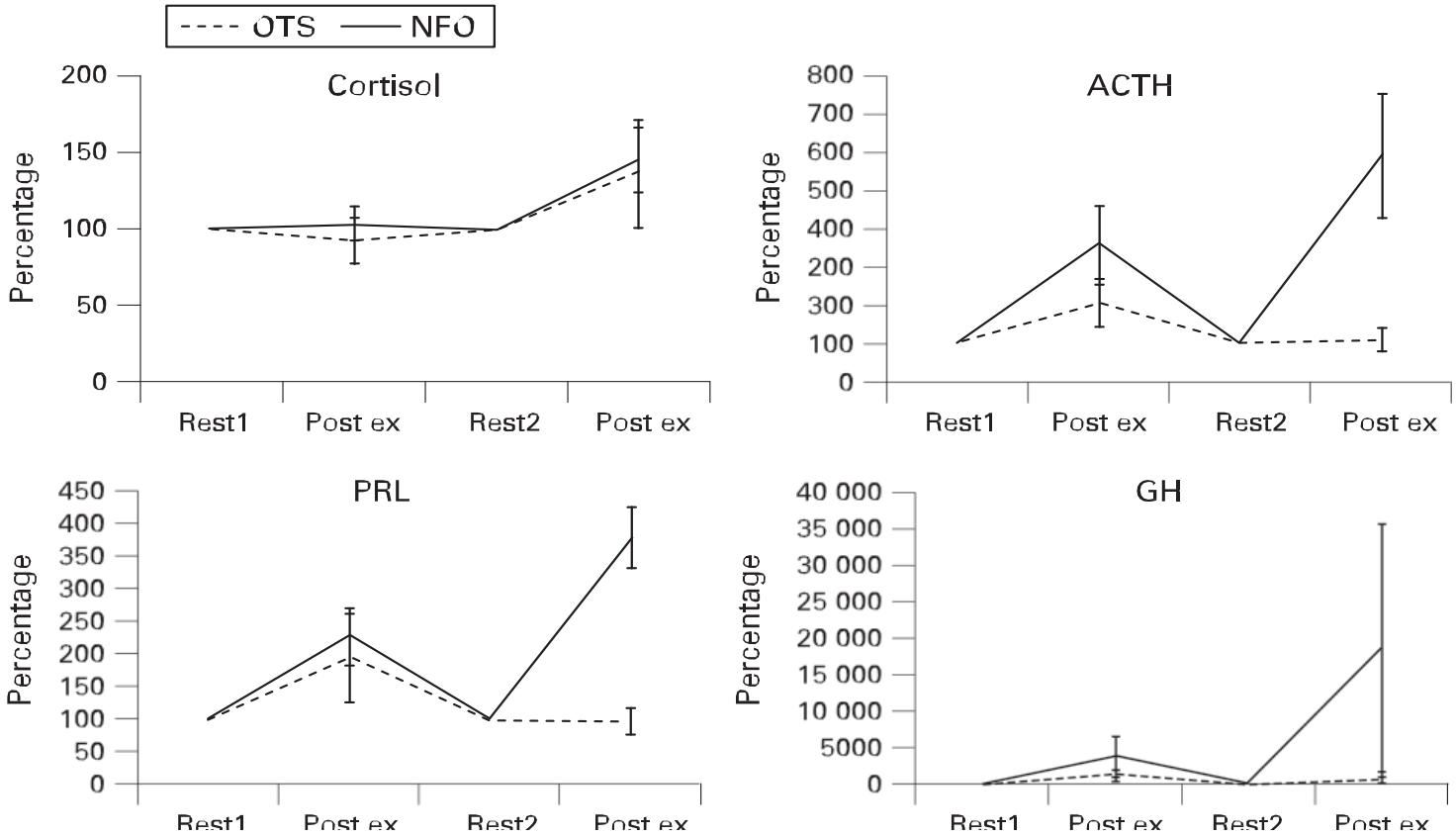


Much lower prolactin and ACTH release in OTS following the second exercise bout. Blood lactate also lower in OTS

Meeusen et al. 2010. Diagnosing overtraining in athletes using the two-bout exercise protocol. *Br J Sports Med* 44:642-648

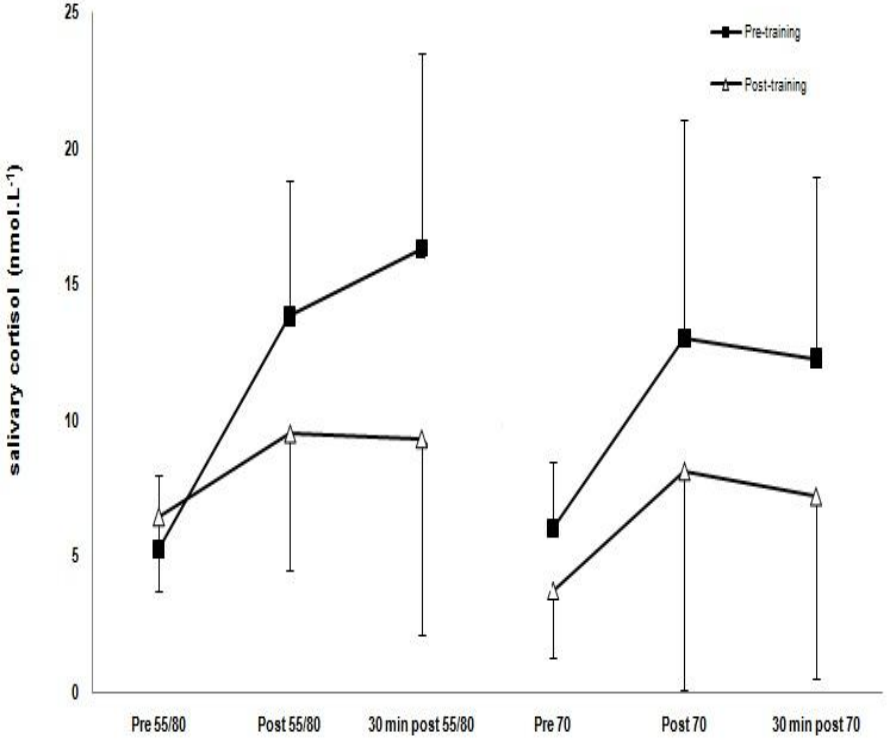
Two graded exercise tests to exhaustion (~20-25 min) performed 4 h apart
Overshoot of ACTH and PRL responses to bout #2 in NFO but blunting in OTS

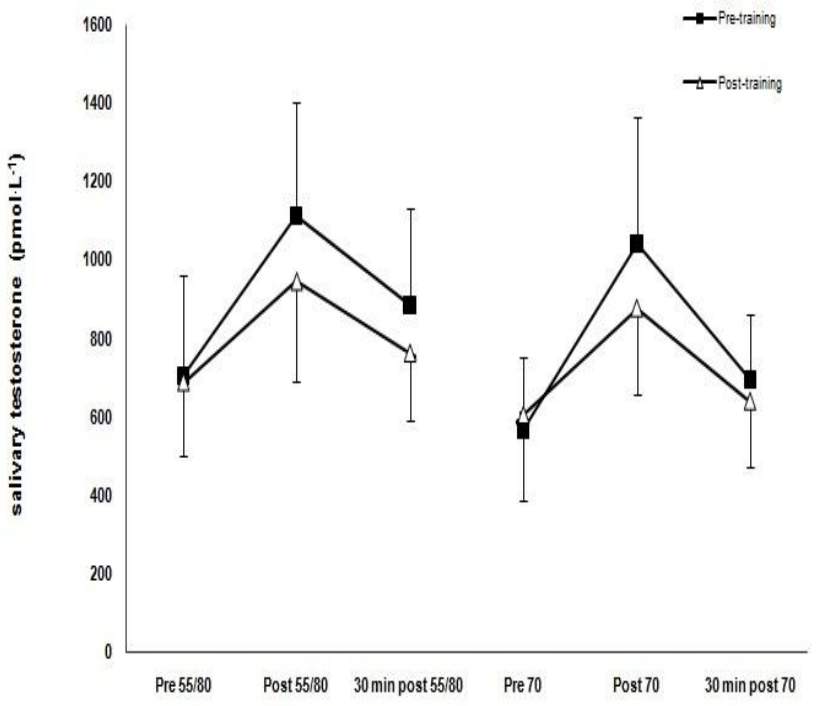
OTS = Overtraining Syndrome; NFO = nonfunctional overreaching



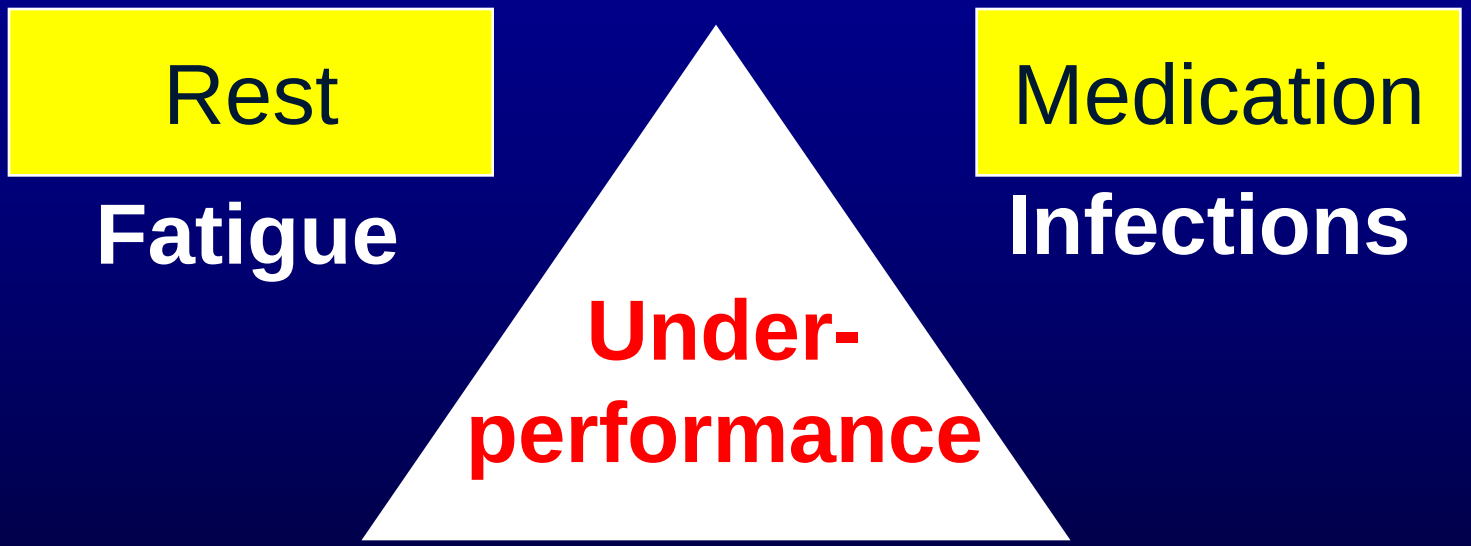
DETECTION OF OVER-REACHING: Salivary cortisol and testosterone responses to a two-bout exercise protocol are blunted after 11 days of intensified training (*John Hough PhD thesis 2012*)

Bout 1: 30 min intermittent 55%W_{max}[1min]/80%W_{max} [4min]
Bout 2: 70%W_{max} for 30 min or to fatigue (if sooner)





Treatment of overtraining



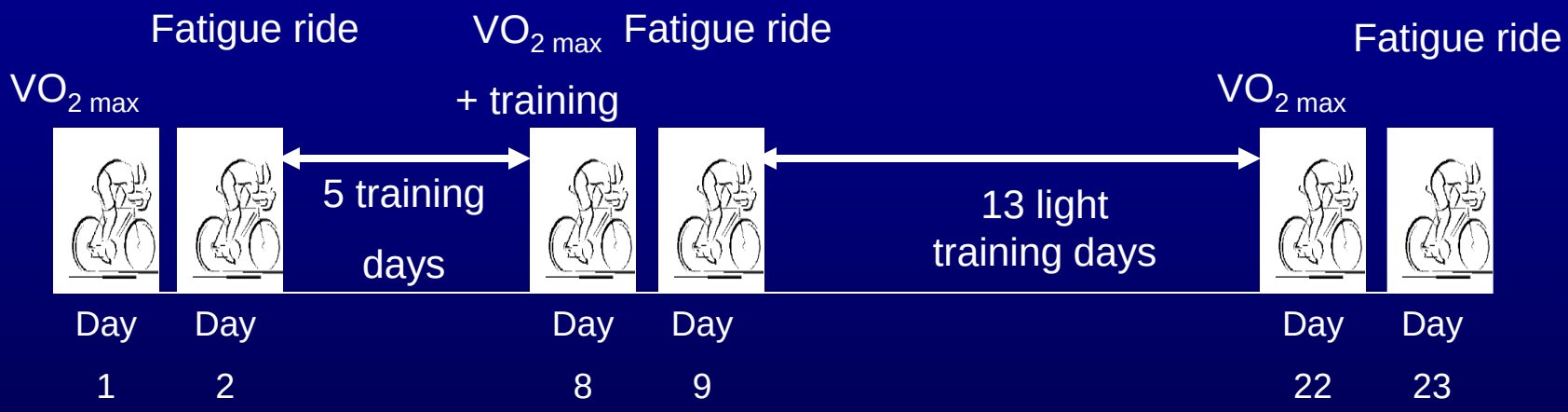
Minimise the stress hormone response to exercise

- Maintain energy balance
- Eat a high carbohydrate diet
- Avoid Dehydration
- Consume carbohydrate and fluid during and after exercise
- Supplement diet with antioxidants
- Allow adequate recovery between training sessions

Overtraining Study +/- CHO supplements

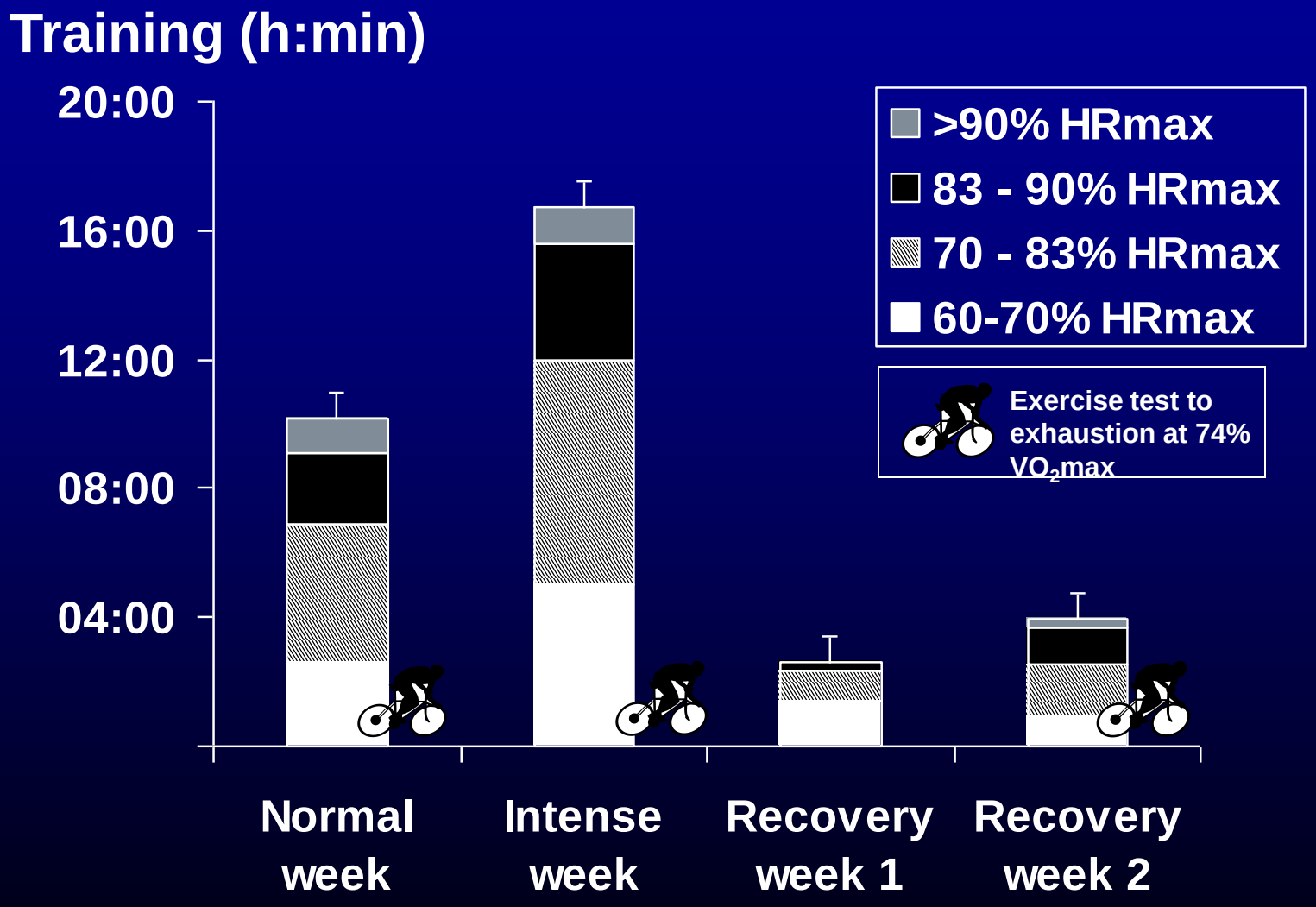
Halson SL et al 2004 J Appl Physiol 97(4): 1245-1253

NORMAL | INTENSIFIED | RECOVERY

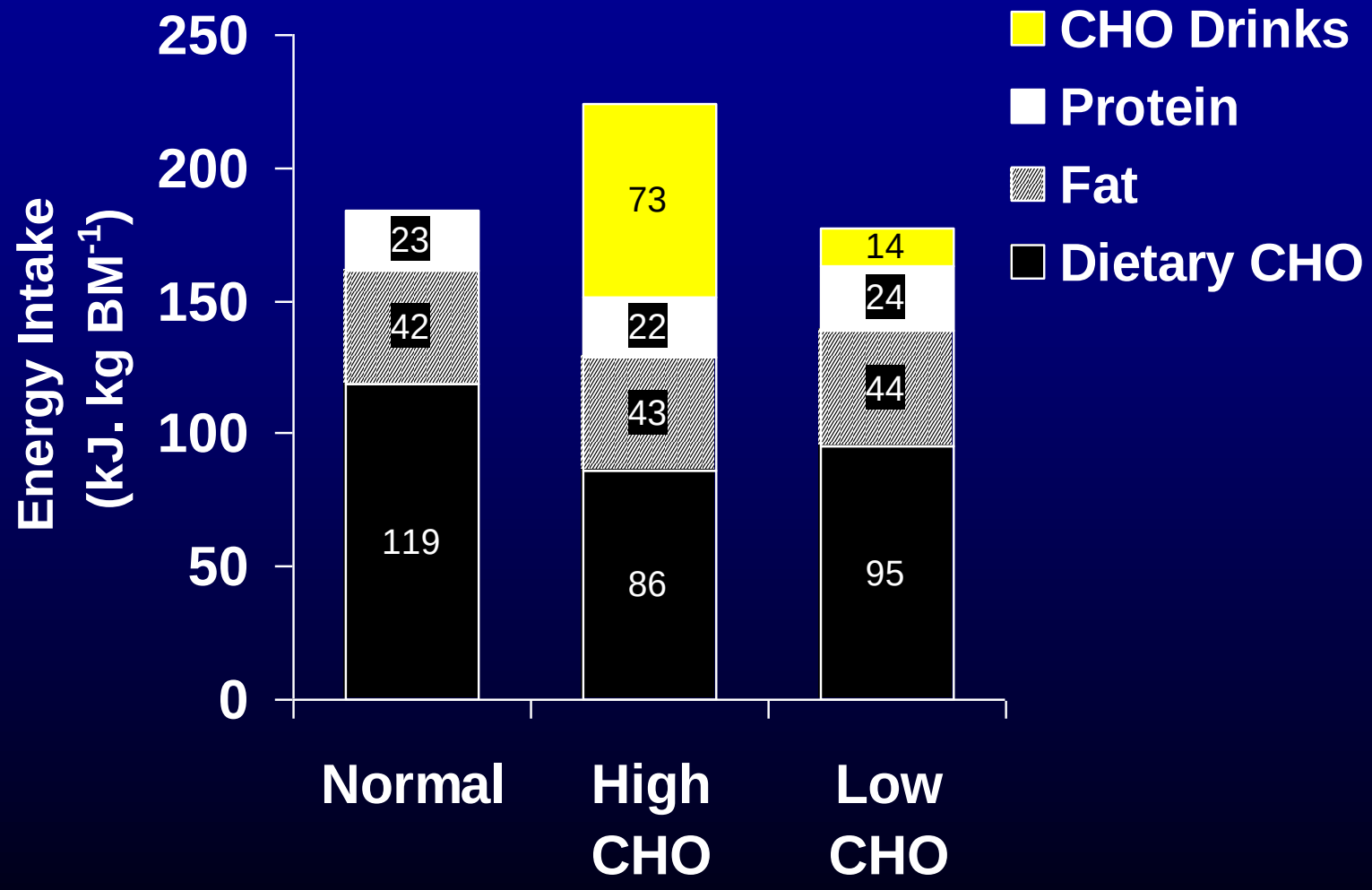


	Pre-exercise	During-exercise	Post-exercise
High CHO	6.4% (32g) 500ml	6.4% (32g) 500ml / hr	20% (200g) 1000ml
Low CHO	2% (10g) 500ml	2% (10g) 500ml / hr	2% (20g) 1000ml

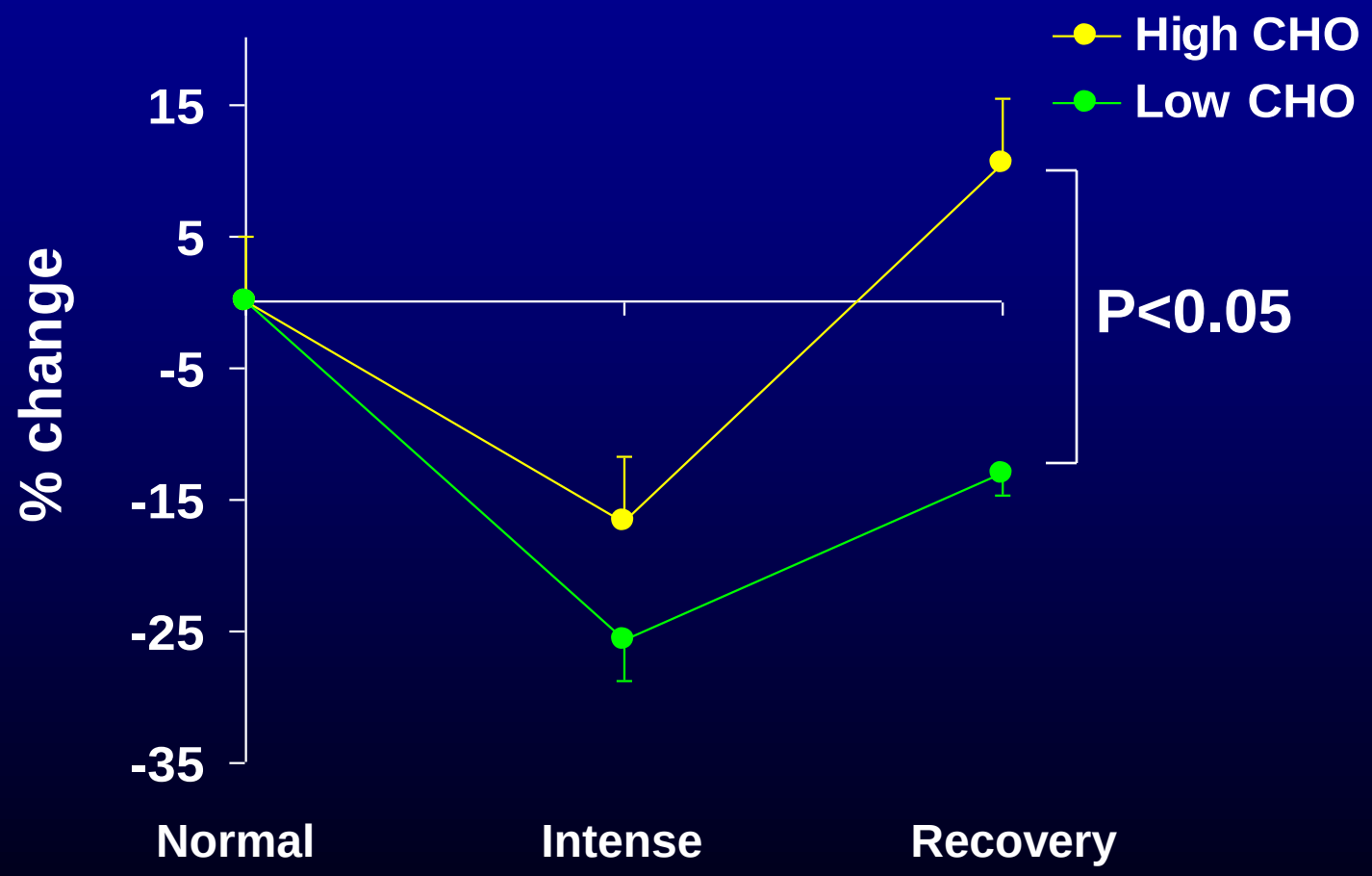
Volume and intensity of training performed during normal training, intensified training and recovery periods



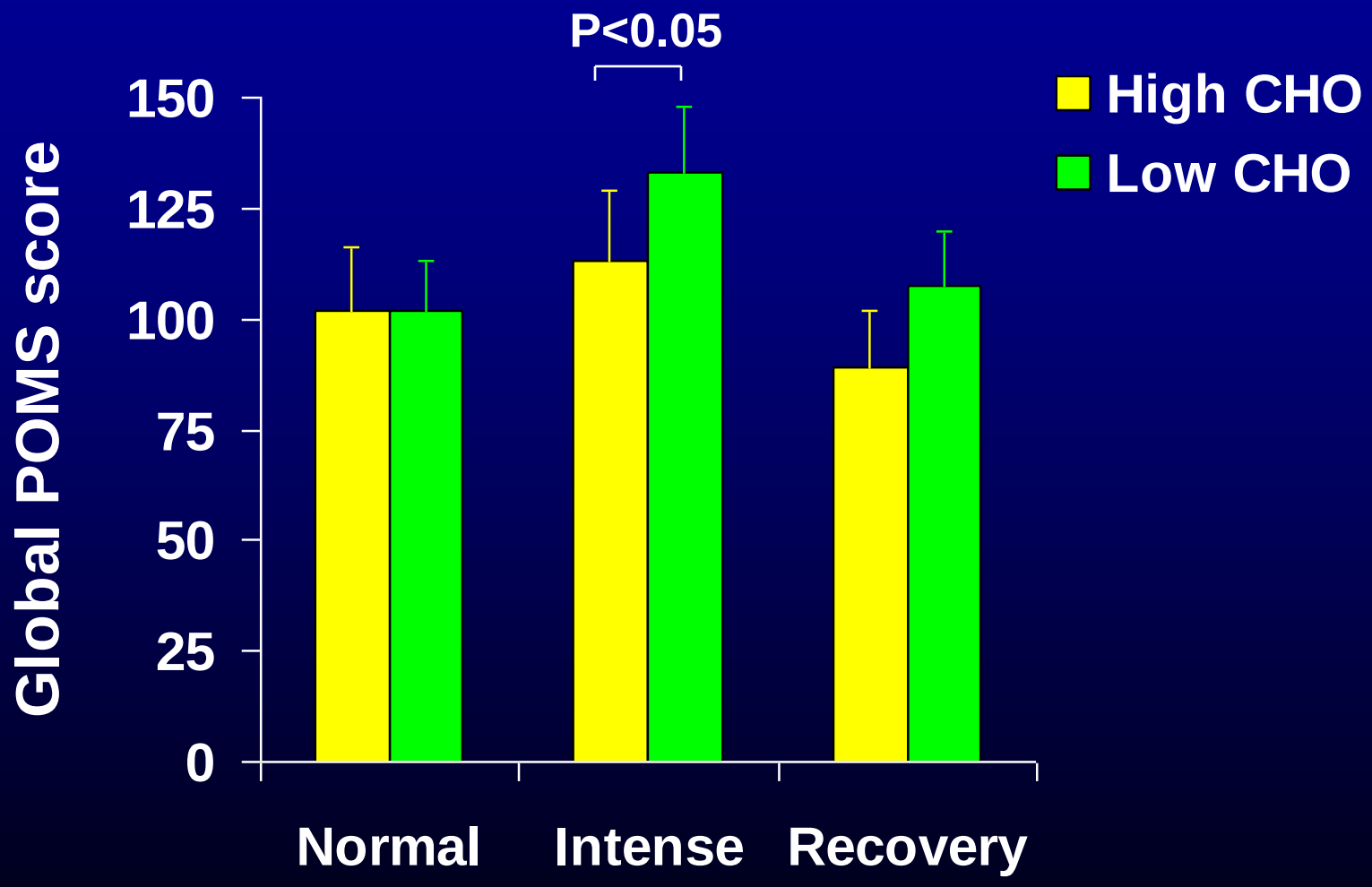
Total energy intake during a period of normal training and during periods of intensified training with supplementary high or low CHO drinks



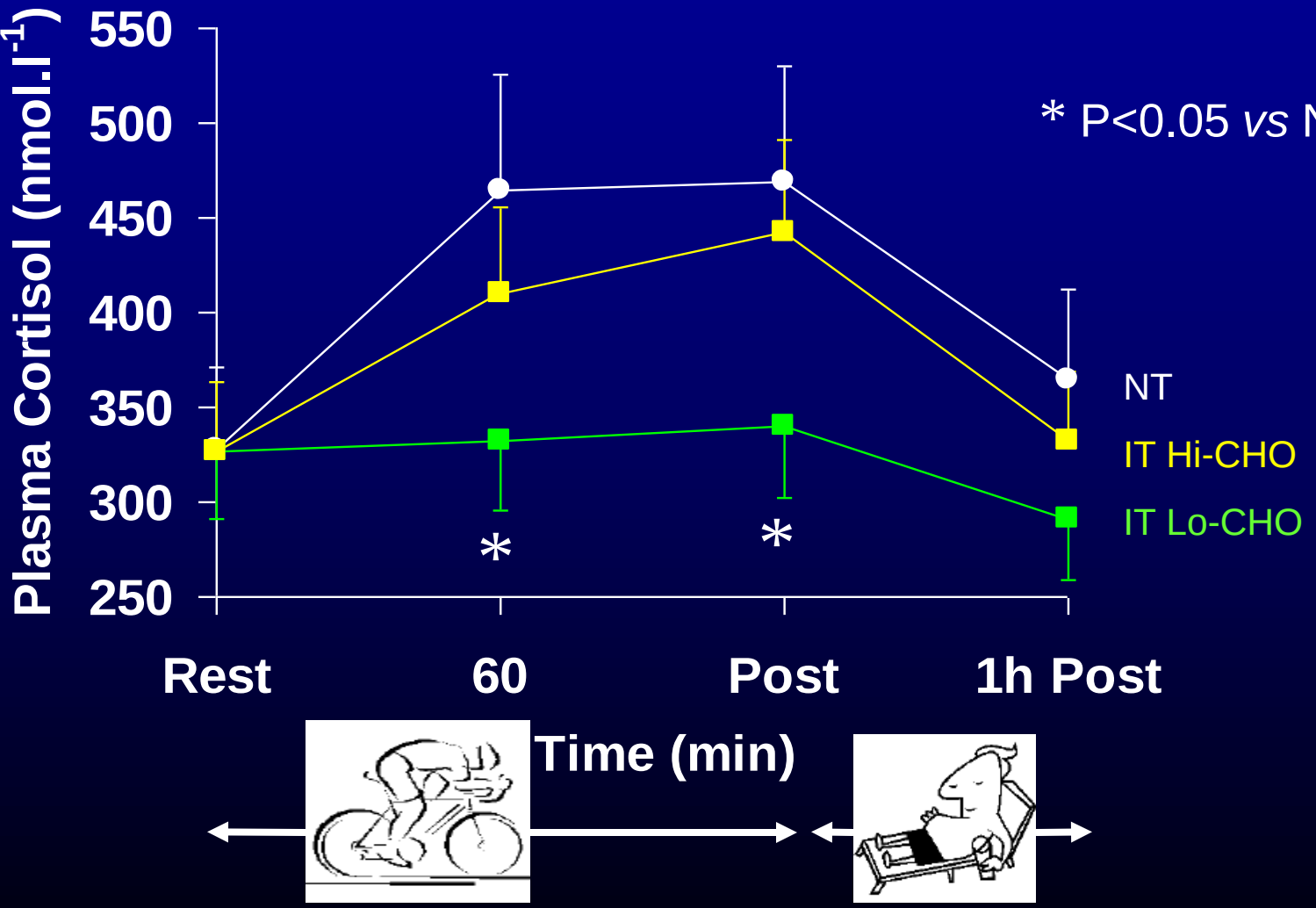
Percentage changes from baseline for exercise time to fatigue during low and high CHO trials



Alterations in mood state during low and high CHO trials



Plasma cortisol response to exercise during Normal Training (NT) and Intensified Training (IT)



Similar results in a run training study

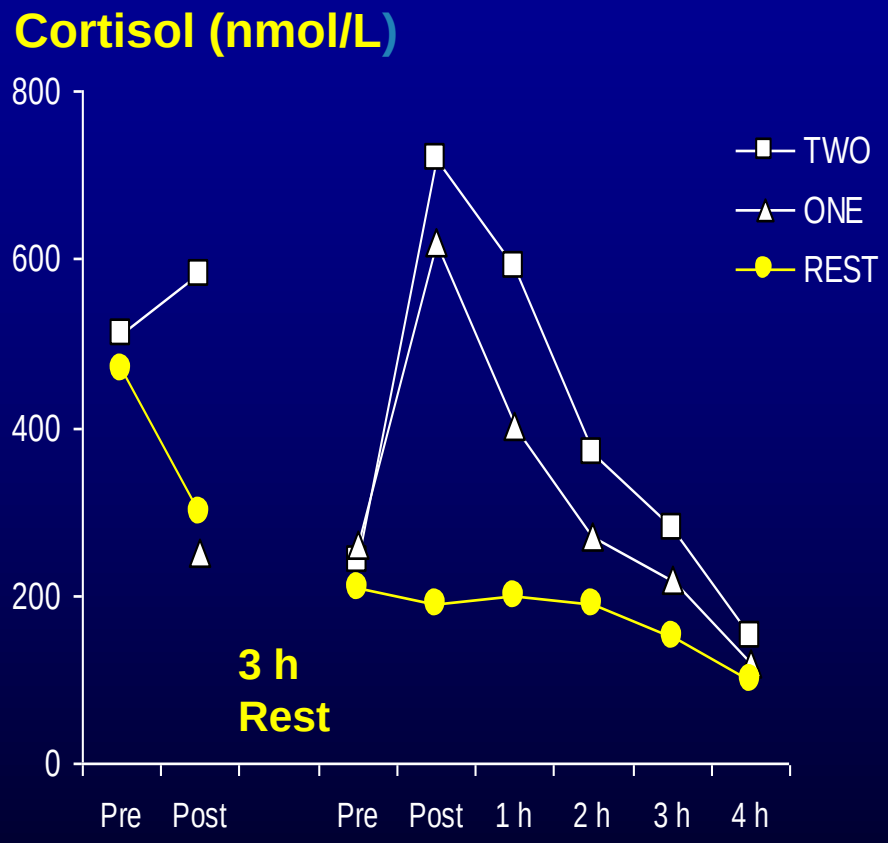
Achten J *et al* (2004)
Higher dietary carbohydrate content during intensified running training results in better maintenance of performance and mood state. *J Appl Physiol* 96(4): 1331-1340

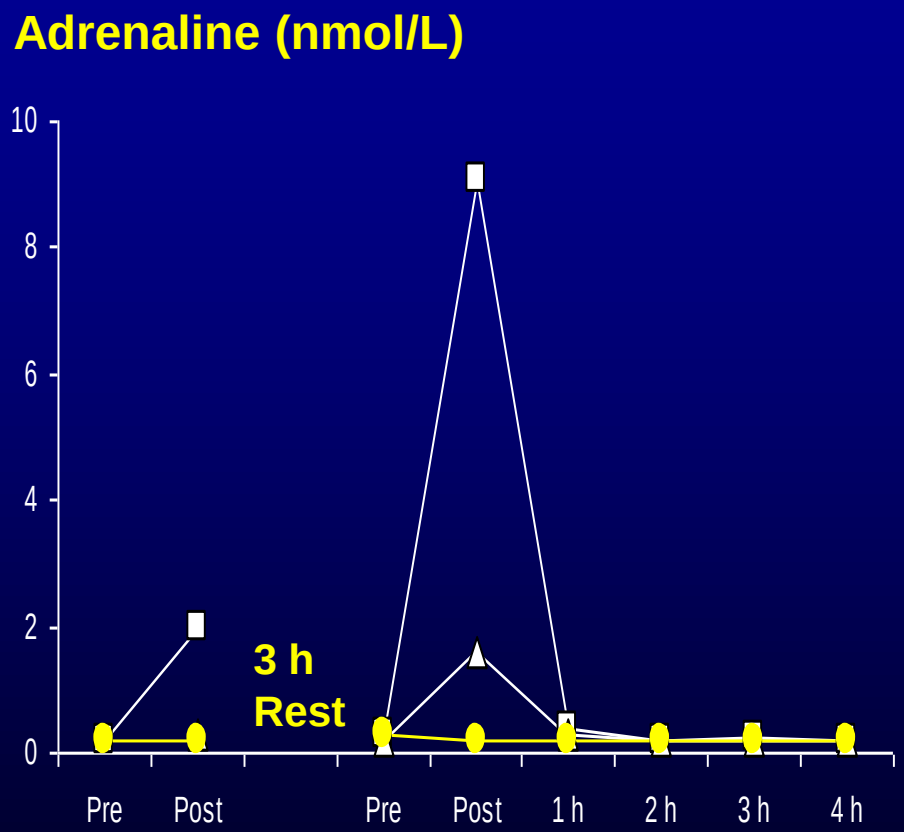
Isoenergetic diets
5.4 g CHO/kg (41%) *vs* 8.5 g CHO/kg (65%)

Minimise the stress hormone response to exercise

- Maintain energy balance
- Eat a high carbohydrate diet
- Avoid Dehydration
- Consume carbohydrate and fluid during and after exercise
- Supplement diet with antioxidants
- Allow adequate recovery between training sessions

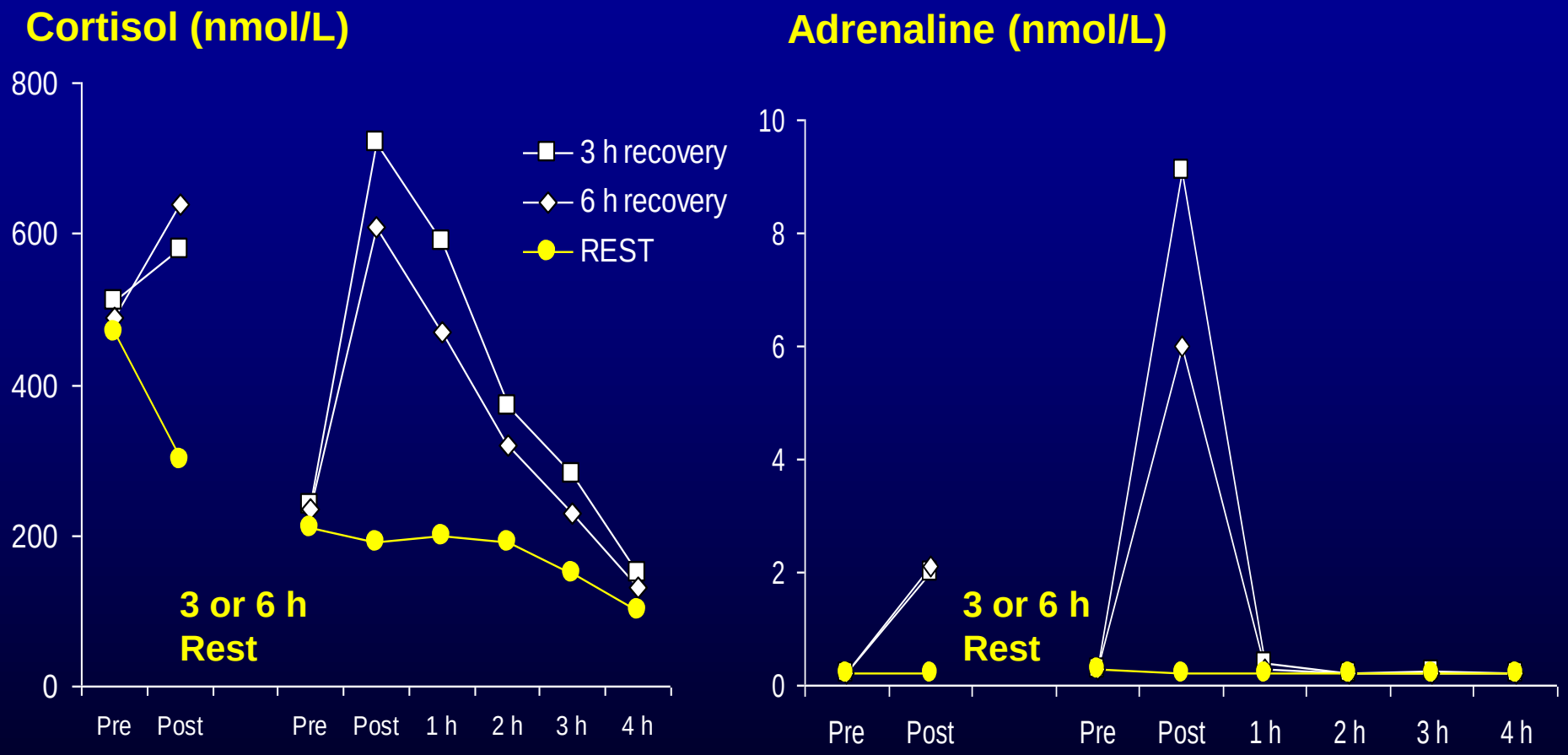
Increased stress hormone response to a repeated bout of endurance exercise (65 min cycling at 75%VO_2max)





Ronsen et al (2001) MSSE 33: 568-575

Longer recovery time decreases the stress hormone response to a repeated bout of endurance exercise (65 min cycling at 75%VO_2max)



Ronsen et al (2002) Am J Physiol 283: C1612-20

Monitoring overtraining DALDA

a = worse than normal, b = normal, c = better than normal

Part A

From Rushall, 1990

1. a b c Diet
2. a b c Home-life
3. a b c School/College/Work
4. a b c Friends
5. a b c Sport training
6. a b c Climate
7. a b c Sleep
8. a b c Recreation
9. a b c Health

Total “a” response _____

Total “b” response _____

Total “c” response _____

Record these values and the day’s date on the data log part A

DALDA = Daily Analyses of Life Demands in Athletes

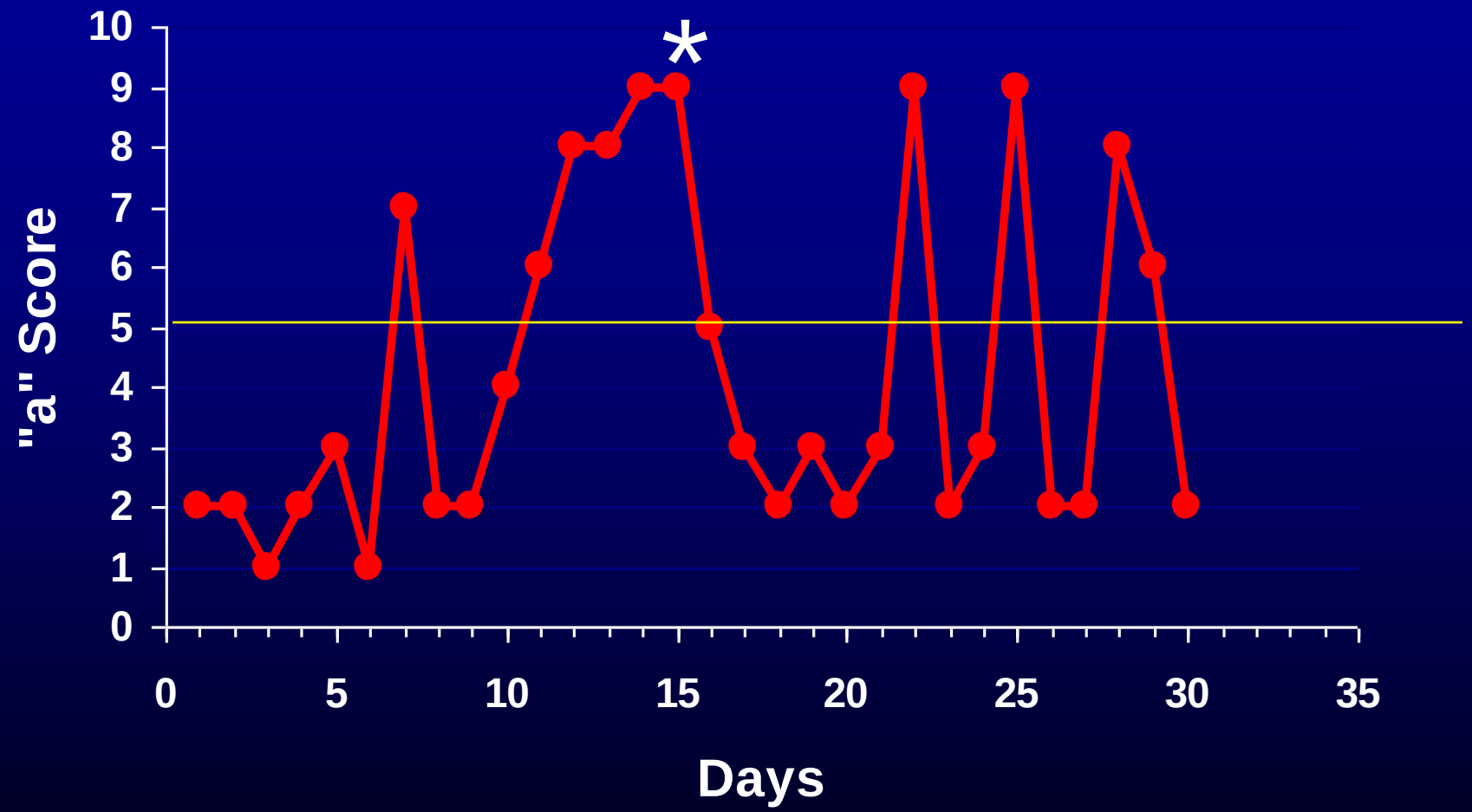
DALDA Part B

1. a b c Muscle pains
2. a b c Techniques
3. a b c Tiredness
4. a b c Need for a rest
5 a b c Supplementary work
6. a b c Boredom
7. a b c Recovery time
8. a b c Irritability
9. a b c Weight
10. a b c Throat
11. a b c Internal
12. a b c Unexplained aches
13. a b c Technique strength
14. a b c Enough sleep
15. a b c Between sessions recovery
16. a b c General weakness
17. a b c Interest
18. a b c Arguments
19. a b c Skin rashes
20. a b c Congestion
21. a b c Training effort
22. a b c Temper
23. a b c Swellings
24. a b c Likability
25. a b c Running nose

a = worse than normal
b = normal
c = better than normal

Sum of “a” scores for DALDA Part B

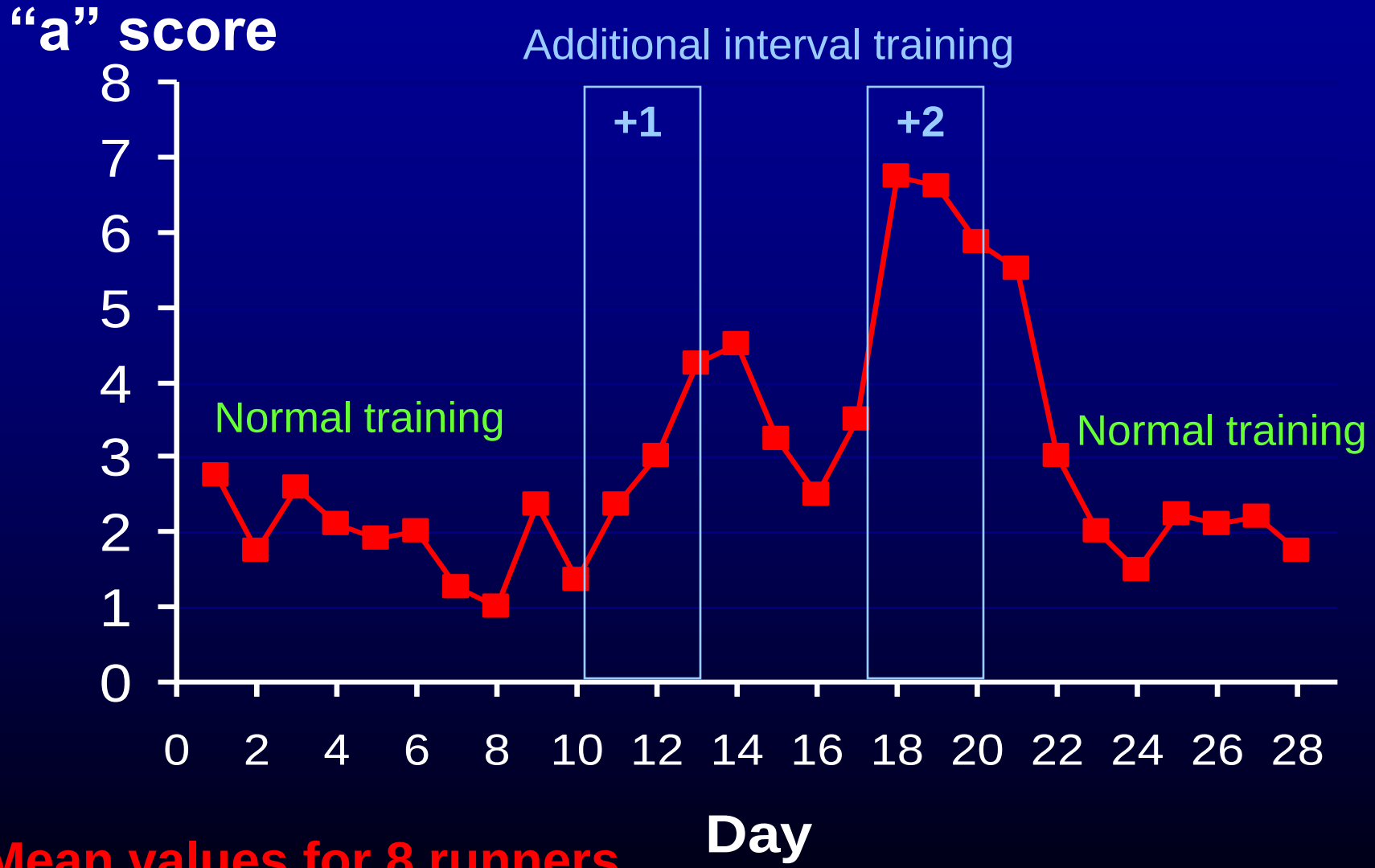
Monitoring overtraining using DALDA



* "a" score >5 for >4 consecutive days

Monitoring overtraining in runners

PJ Robson, PhD thesis, University of Birmingham, 1999



Mean values for 8 runners

Essentials to avoid overtraining

- Control rate of progression of training
- Reduce risks of infection
- Avoid monotonous training
- Maintain good nutrition
- Ensure adequacy of carbohydrate and energy intake during intensified training periods
- Monitor the training load and the athlete

Thank you for listening!