Recovery of neuromuscular function following competitive football match-play

Dr. Callum Brownstein

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

IDEX LYON UNIVERSITÉ DE LYON

ActiFS Activité Physique Fatigue Santé

libm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

Contents

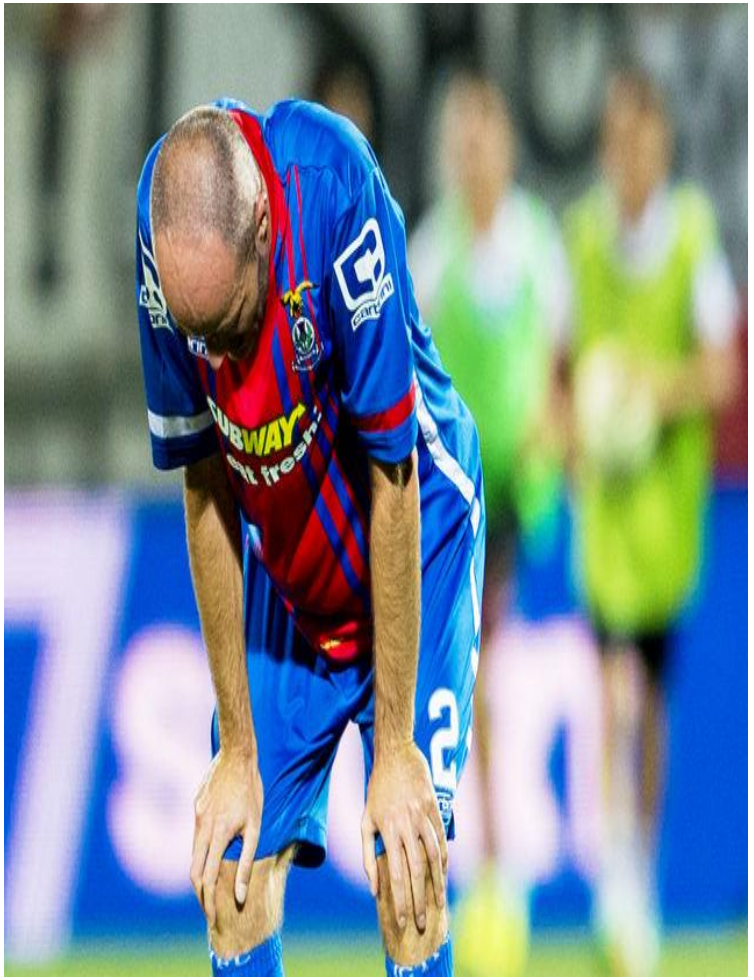
- Demands of football match-play
- Importance of recovery in modern football
- Fatigue and recovery, what is known?
- Recovery of neuromuscular function following football match-play
- The effect of phase change material (cryotherapy) on recovery of neuromuscular function following football match-play
- Practical implications: training scheduling, fixture congestion and recovery strategies

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Demands of competitive football match-play

Typical match-demands (aerobic)

- Total distance: 10-13 km
- High-intensity running: 2-3 km
- Average heart rate: 80-90% HR max
- Average VO_2: 70-80% of VO_{2max}
- **Substantial aerobic demand**



Mohr *et al*. (2003); Bradley *et al.* (2009); Barnes *et al*., (2014)

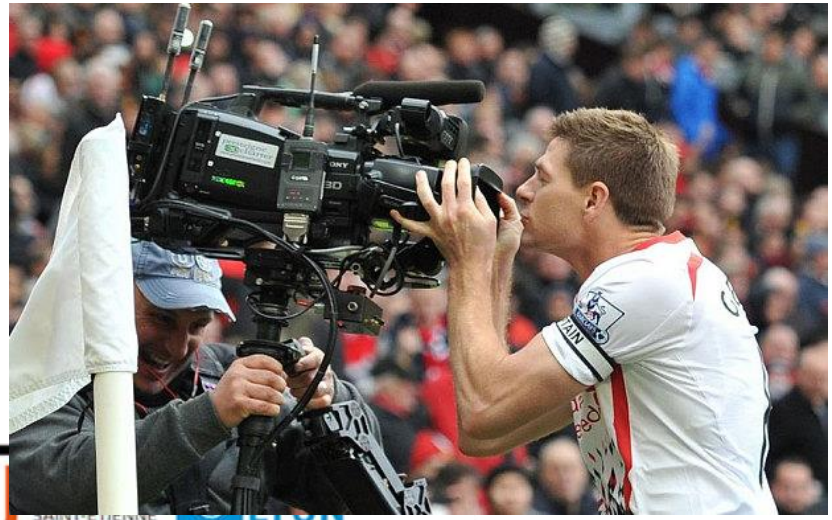
Demands of competitive football match-play

Typical match-demands (anaerobic)

- 1500 activities performed per-match
- Sprint distance (200-400 m)
- Change in activity every 4-6 s
  - Jumping/landing
  - Tackling
  - Accelerating/decelerating
  - Changing direction
  - Kicking
- **High anaerobic energy turnover**
- **Substantial muscle damage**

Akenhead *et al*. (2013); Nielsen *et al*. (2012)

Demands of competitive football match-play



UNIVERSITÉ DE LYON

ActiFS
Activité Physique Fatigue Santé

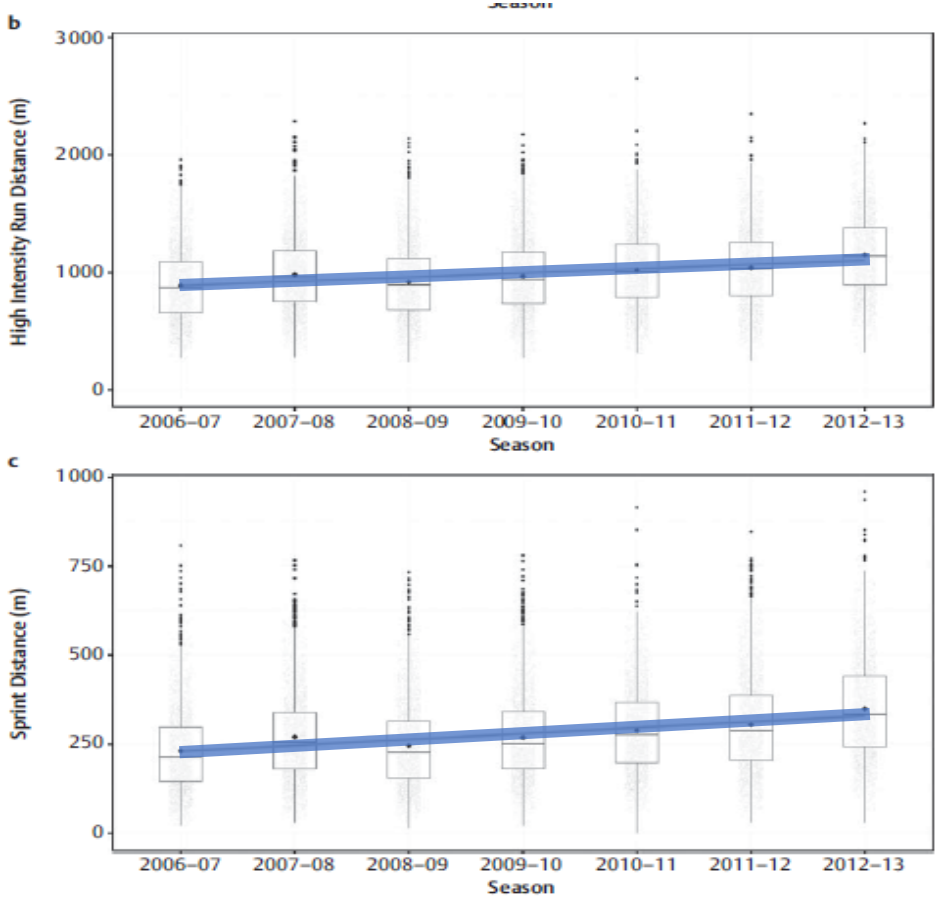
libm
Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University
NEWCASTLE

Increasing demands of competitive football match-play

Barnes et al (2014)

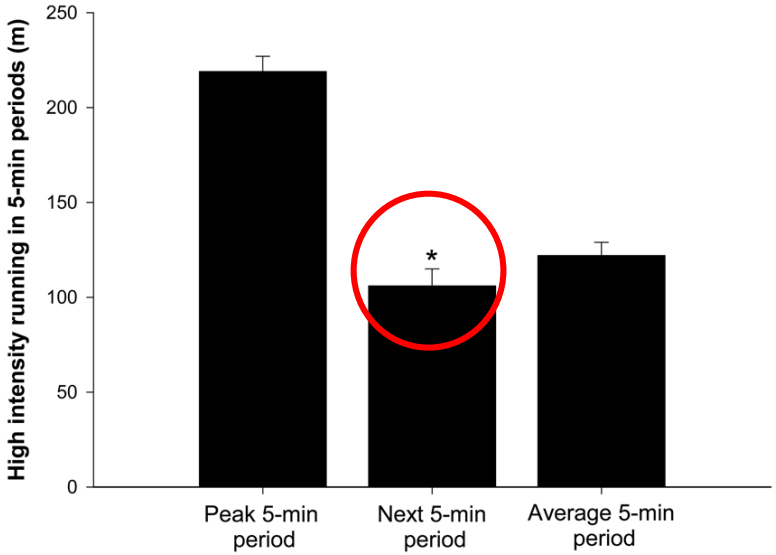
- Study conducted between 2006/07 and 2012/13.
- ~30% increase in high-intensity running
- ~35% increase in sprint distance
- ~85% increase in number of sprints



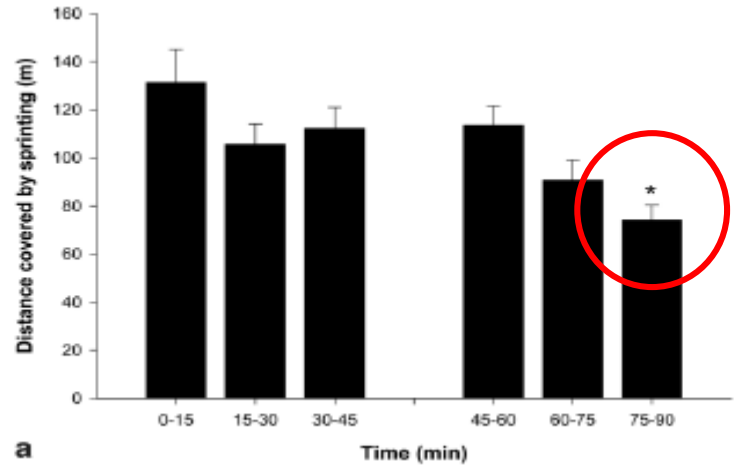
UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

Fatigue during match-play: match-running performance



Transient fatigue: temporary reductions in work-rate following the most intense periods of a match



Cumulative fatigue: reductions in work-rate towards the end of a match.

Mohr *et al*. (2005)

Fatigue during match-play: technical performance and injury risk

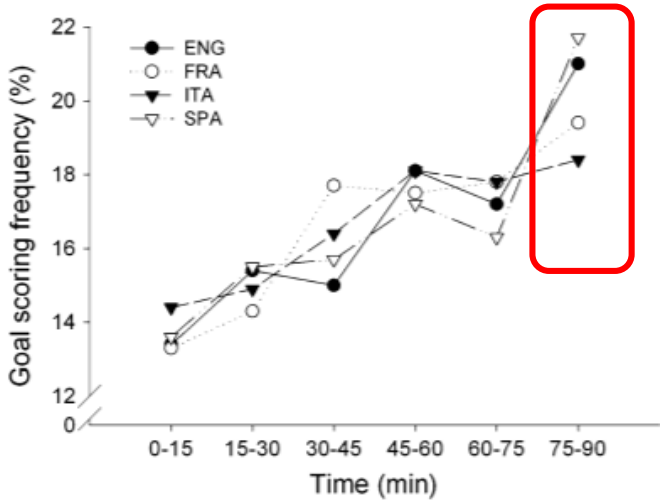


Table 2 Differences between first and second half in physical and technical performance during official soccer matches of the Italian Serie A ($n = 416$)

Variables	First half	Second half	Difference mean value	Difference 95% CI
Physical data (m)				
Total distance	5966	5862	−104	−145 to −61
High-intensity running	2038	1909	−129	−176 to −83
Very high-intensity running	633	591	−42	−66 to −18
Total distance with the ball	250	237	−13	−22 to −3
High-intensity running with the ball	142	130	−12	−19 to −5
Very high-intensity running with the ball	60	55	−5	−9 to 1
Technical data (number)				
Involvement with the ball	20.4	18.7	−1.7	−2.4 to −1.0
Short passes	12.0	10.8	−1.2	−1.8 to −0.7
Successful short passes	11.1	10.0	−1.1	−1.6 to −0.5
Percentage of successful short passes	91.6	91.3	0.3	−2.2 to 1.5
Long passes	2.2	1.9	−0.3	−0.5 to 0.1
Successful long passes	1.4	1.3	0	−0.3 to 0.1
Crosses	41.8	42.8	1.0	−3.9 to 5.9
Headers	0.6	0.6	−0.1	−0.1 to 0.1
Tackles	1.3	1.2	0	−0.3 to 0.1
Dribbling	0.7	0.7	−0.1	−0.1 to 0.2
Shots	0.4	0.3	−0.1	−0.1 to 0.1
Shots on target	0.7	0.7	0	−0.1 to 0.1

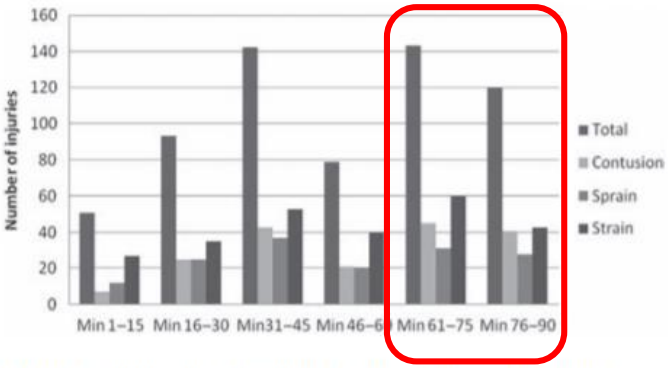


Figure 1 Distribution of traumatic injuries during a match (data from the 2006/07 and 2007/08 seasons).

Alberti et al., 2013; Rampinini et al., 2009; Ekstrand et al., 2011

Fatigue and recovery following football match-play

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

IDEX LYON UNIVERSITÉ DE LYON

ActiFS Activité Physique, Fatigue, Santé

libm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

Fatigue and recovery in football: what is known?

Time-course of recovery:

- Sprint speed

- 5 hours (Andersson *et al*., 2008)
- 96 hours (Ascensao *et al*., 2008; Magalhaes *et al*., 2010)

- Countermovement jump (CMJ) height

- 48 hours (Ispirlidis *et al*., 2008; Fatouros *et al*., 2009)
- 72 hours (Andersson *et al*., 2008; Magalhaes *et al*., 2010)

- Maximal voluntary contraction (MVC)

- 48 hours (Rampinini *et al*., 2011)
- > 72 hours (Thomas *et al*., 2017; Ascensao *et al*., 2008)

Northumbria University NEWCASTLE

Fatigue and recovery in football: what is known?

Sports Med
DOI 10.1007/s40279-017-0798-8

SYSTEMATIC REVIEW

Acute and Residual Soccer Match-Related Fatigue: A Systematic Review and Meta-analysis

J. R. Silva[1,2] · M. C. Rumpf[1,3] · M. Hertzog[1] · C. Castagna[4] · A. Farooq[5] · O. Girard[5,6] · K. Hader[1,7]

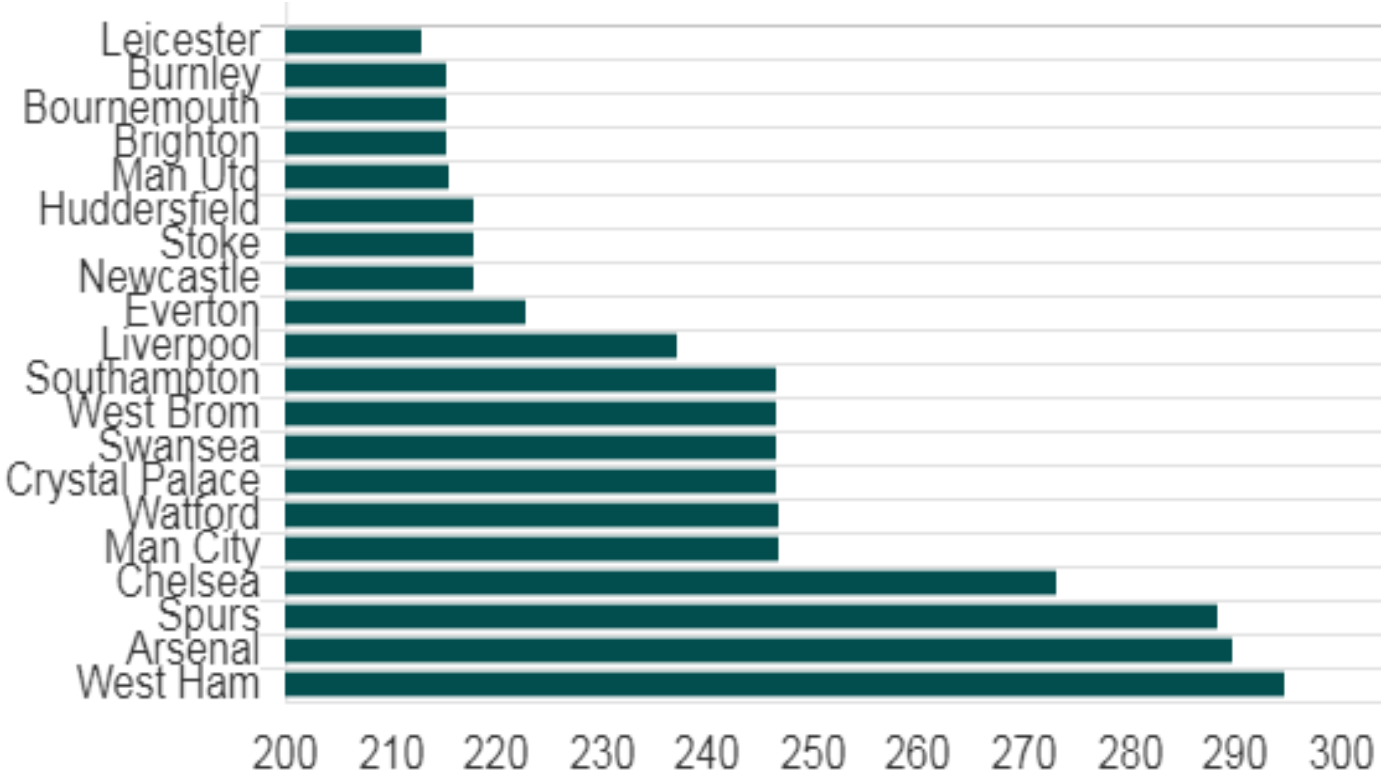
"While some parameters are recovered, our systematic review shows that a period of 72 h post-match play is not long enough to completely restore homeostatic balance."

"Overall, coaches must adjust the structure and content of the training sessions during the 72 h post-match intervention to effectively manage the training load within this time-frame."

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Recovery in football: a topical area

Hours between start of first fixture and end of last fixture during the festive period



53 hours

74 hours

Université Jean Monnet Saint-Étienne

IDEX Lyon Université de Lyon

ActiFS Activité Physique Fatigue Santé

libm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University Newcastle

Recovery in football: a topical area

Pep Guardiola: Man City boss says fixture list congestion a 'disaster' for players

2 January 2018 | Man City | Share

Kevin de Bruyne, who has the most assists in the le

West Brom make formal complaint to Premier League over their 'terrible' fixture congestion

share 2

Alan Pardew isn't happy with West Brom's congested fixture

Chelsea: Guus Hiddink wants doctors to challenge fixture calendar

28 February 2016 | Football Share

Chelsea attacker Pedro suffered a hamstring injury in the win over Southampton

Chelsea manager Guus Hiddink says Premier League club doctors should put pressure on the game's authorities to change the fixture calendar.

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

IDEX LYON UNIVERSITÉ DE LYON

ActiFS Activité Physique Fatigue Santé

Slibm Laboratoire Interuniversitaire de Biologie de la Motricité

thumbria University NEWCASTLE

Recovery in football: a topical area

Original article

Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study

Håkan Bengtsson,[1] Jan Ekstrand,[1,2,3] Martin Hägglund[1,4]

Effect of 2 Soccer Matches in a Week on Physical Performance and Injury Rate

Gregory Dupont,*†‡ PhD, Mathieu Nedelec,†‡ MSc, Alan McCall,‡ MSc, Derek McCormack,‡ MD, Serge Berthoin,† PhD, and Ulrik Wisløff,§ PhD
From the †Laboratory of Human Movement Studies, EA 3608, Artois and Lille 2 Universities, France, ‡Celtic Lab, Sport Science Department, Celtic FC, Glasgow, Scotland, and the §Department of Circulation and Medical Imaging, Norwegian University of Science and Technology, Trondheim, Norway

Original article

The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team

Alexandre Dellal,[1] Carlos Lago-Peñas,[3] Ezequiel Rey,[3] Karim Chamari,[2,4] Emmanuel Orhant[5]

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Recovery in football: a topical area

Original article

Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study

Håkan Bengtsson,[1] Jan Ekstrand,[1,2,3] Martin Hägglund[1,4]

Table 4 Comparison of injury rates in matches with short (four or less days) or long (six or more days) recovery before the match

	≤4 days' recovery	≥6 days' recovery	RR	95% CI	p Value
All injuries					
League	29.0	26.6	1.09	1.00 to 1.18	0.045
UCL	33.0	27.1	1.22	0.85 to 1.75	0.290
EL	24.7	37.9	0.65	0.41 to 1.03	0.064
Other cup	27.8	23.6	1.18	0.94 to 1.47	0.153
Muscle injuries					
League	11.9	9.0	1.32	1.15 to 1.51	<0.001
UCL	13.1	7.9	1.66	0.85 to 3.24	0.135
EL	8.2	16.5	0.50	0.25 to 1.01	0.055
Other cup	10.5	8.3	1.26	0.87 to 1.83	0.218
Ligament injuries					
League	5.0	5.6	0.90	0.75 to 1.09	0.292
UCL	5.7	7.0	0.81	0.39 to 1.67	0.567
EL	3.7	8.2	0.45	0.17 to 1.25	0.126
Other cup	5.6	3.1	1.84	1.03 to 3.30	0.041

EL, Europa League; RR, rate ratio; UCL, UEFA Champions League.
Injury rate is expressed as the number of injuries per 1000 h of match exposure.

Recovery in football: a topical area

Fatigue and recovery in football: what is known?

Recovery in Socc

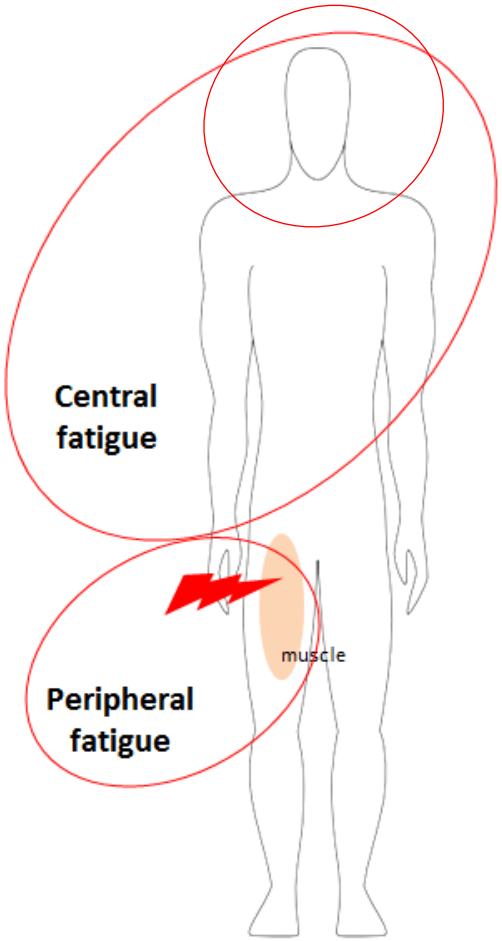
Part I – Post-Match Fatigu

Mathieu Nédélec,[1,2] *Alan McCall*,[1,2] (and *Gregory Dupont*[1,2]

1 Université Lille Nord de France, Lille,
2 LOSC Lille Métropole Football Club, C

Contents

Abstract 997
1. Introduction 998
2. Post-Match Fatigue 998
2.1 Dehydration 999
2.2 Glycogen Depletion 999
2.3 Muscle Damage 1000
2.4 Mental Fatigue 1001
2.5 Summary 1001
3. Time Course of Recovery Markers 1001
3.1 Magnitude of Fatigue 1003
3.2 Relevance of Recovery Markers 1005
3.2.1 Physical Performance Mar 1008
3.2.2 Cognitive Function 1008
3.2.3 Subjective Markers 1008
3.2.4 Biochemical Markers 1010
4. Conclusion 1010



Université Jean Monnet Saint-Étienne
IDEX Lyon Université de Lyon
ActiFS Activité Physique Fatigue Santé
Slibm
Northumbria University Newcastle

Fatigue and recovery in football: what is known?

frontiers in PHYSIOLOGY

REVIEW ARTICLE
published: 03 February 2014
doi: 10.3389/fphys.2014.00024

Is recovery driven by central or peripheral factors? A role for the brain in recovery following intermittent-sprint exercise

Geoffrey M. Minett[1,2]* and Rob Duffield[3]

[1] School of Exercise and Nutrition Sciences, Queensland University of Technology, Kelvin Grove, Brisbane, QLD, Australia
[2] Institute of Health and Biomedical Innovation, Queensland University of Technology, Kelvin Grove, Brisbane, QLD, Australia
[3] Sport and Exercise Discip

Is it time to turn our attention toward central mechanisms for post-exertional recovery strategies and performance?

Ben Rattray[1,2]*, Christos Argus[2], Kristy Martin[1,2], Joseph Northey[1,2] and Matthew Driller[3]

[1] Discipline of Sport and Exercise Science, Faculty of Health, University of Canberra, Canberra, ACT, Australia, [2] University of Canberra Research Inst and Leisure Studies, Th

JOURNAL OF SPORTS SCIENCES, 2016
VOL. 34, NO. 14, 1296
http://dx.doi.org/10.1080/02640414.2016.1170475

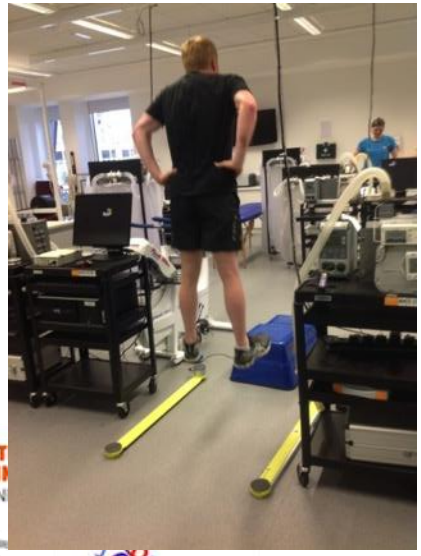
EDITORIAL

Fatigue in football: it's not a brainless task!

Minett & Duffield, 2014; Rattray *et al*., 2015; Coutts, 2016

Aims

To examine the aetiology of fatigue and the time-scale of recovery following competitive football match-play



To profile the time-course recovery of a range of simple measures of perceptual & physical function as markers of readiness to train

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

ActiFS Activité Physique, Fatigue, Santé

Slibm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

Aims

frontiers in Physiology

ORIGINAL RESEARCH
published: 25 October 2017
doi: 10.3389/fphys.2017.00831

Etiology and Recovery of Neuromuscular Fatigue following Competitive Soccer Match-Play

*Callum G. Brownstein[1], Jack P. Dent[1], Paul Parker[1], Kirsty M. Hicks[1], Glyn Howatson[1,2], Stuart Goodall[1] and Kevin Thomas[1]**

[1] Department of Sport, Exercise and Rehabilitation, Faculty of Health and Life Sciences, Northumbria University, Newcastle-upon-Tyne, United Kingdom, [2] Water Research Group, School of Environmental Sciences and Development, Northwest University, Potchefstroom, South Africa

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Methods

- 16 male semi-professional footballers (level 9 of EFL)
- Players studied over two 90-minute matches
- Measures taken pre-, post-, 24, 48 & 72 h post-match
- Neuromuscular measures:
  - Maximal voluntary contraction
  - Voluntary activation (motor nerve and motor cortical stimulation)
  - Potentiated twitch force
- Corticospinal excitability & SICI
- Physical measures:
  - CMJ
  - Drop-jump RSI
  - 20 m sprint

Northumbria University NEWCASTLE

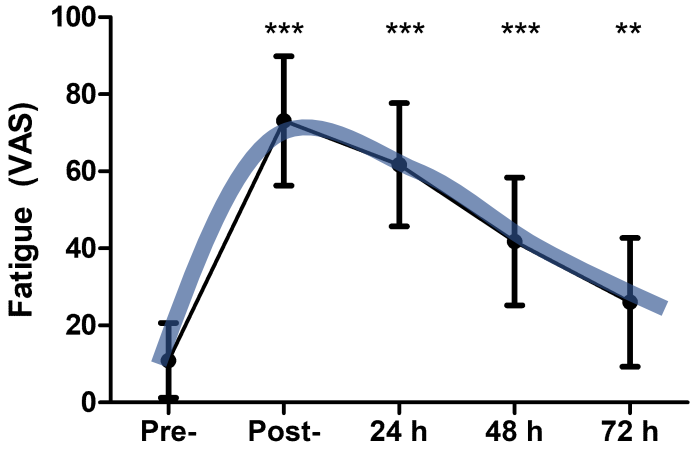
Results

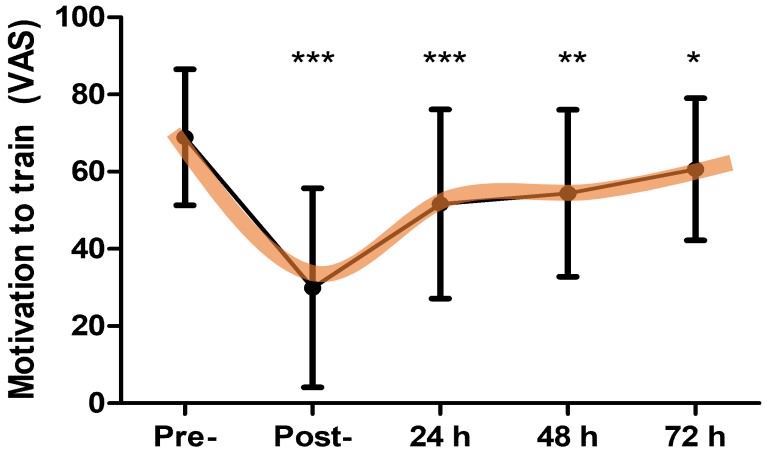
TABLE 3 | Match activity and heart rate variables during competitive soccer match-play.

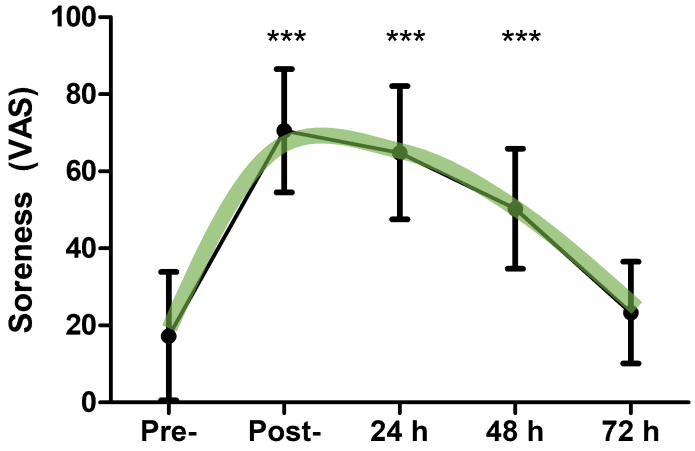
	Total distance (m)	High-intensity (m)	Accels (no.)	Decels (no.)	Mean HR (bpm)	Max HR (bpm)
Pooled data	10,041 ± 626	1,211 ± 257	315 ± 64	208 ± 56	164 ± 11	193 ± 10
Game 1	10,037 ± 552	1,286 ± 199	301 ± 64	197 ± 49	170 ± 11	197 ± 12
Game 2	10,046 ± 770	1,126 ± 303	329 ± 64	218 ± 64	158 ± 7	189 ± 5
Season average	10,076 ± 1,363	1,456 ± 143	289 ± 97	204 ± 63	158 ± 12	194 ± 12

The study data was gathered across two competitive matches, while normative data from the same players was gathered throughout the competitive season (n = 16). Values are mean ± SD. HIR, high-intensity running; Accels, accelerations; Decels, decelerations, HR, heart rate.

Results: perceptual measures

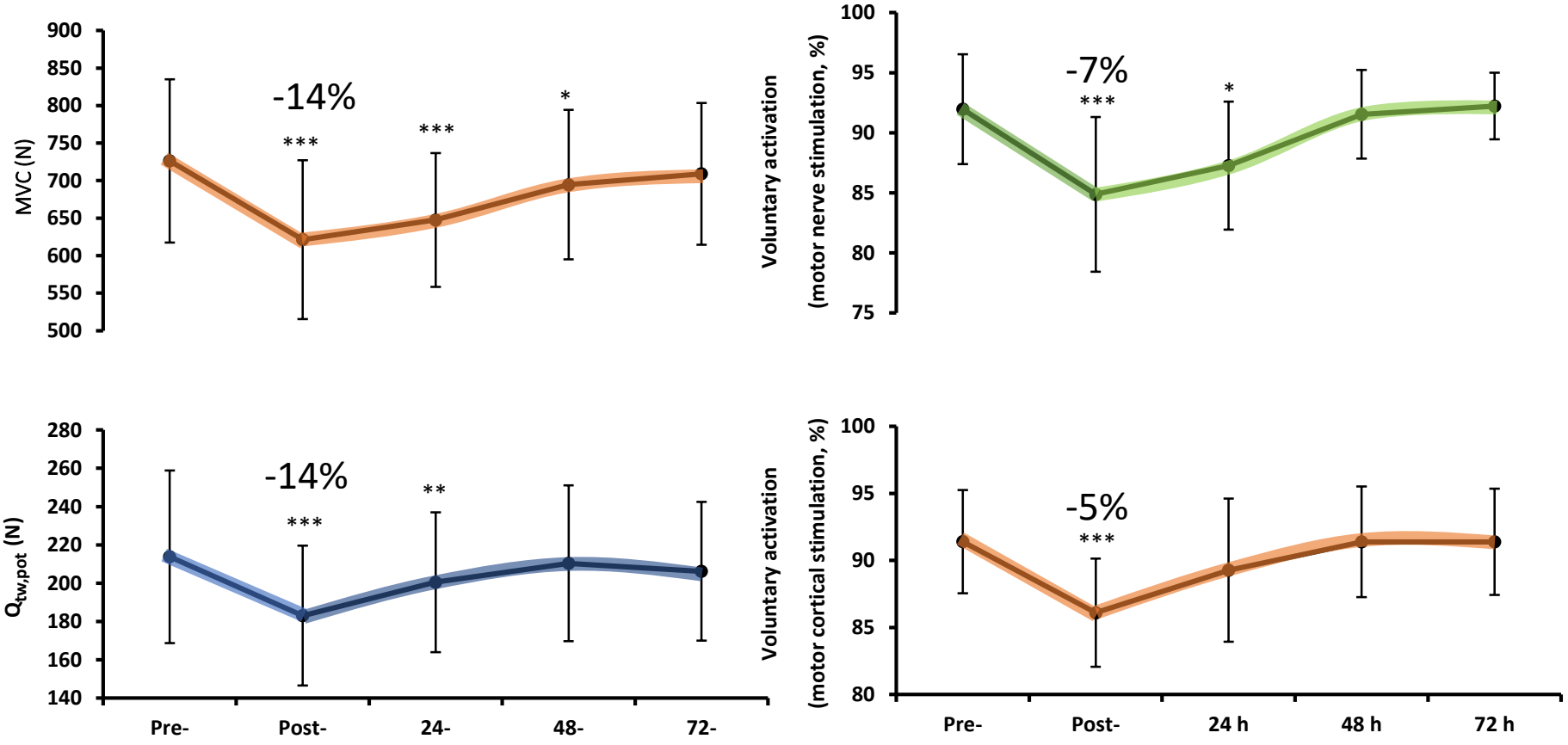






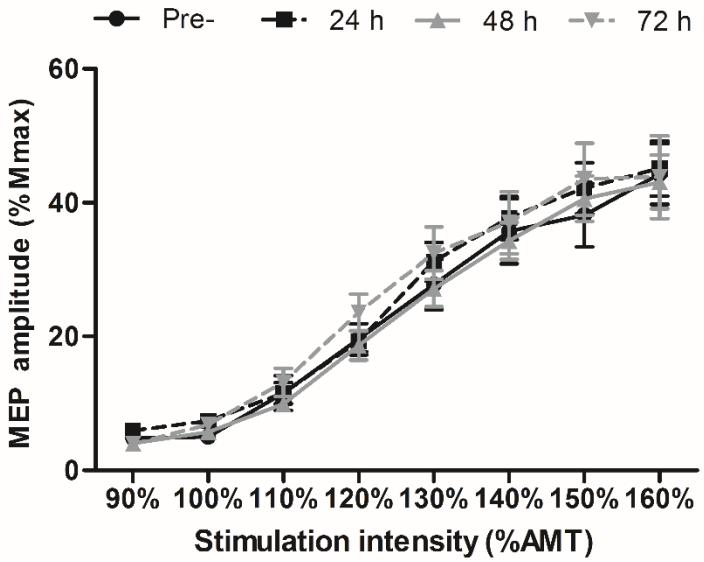
Significant differences indicated by * = $p < 0.05$, ** = $p < 0.01$ and *** = $p < 0.001$.

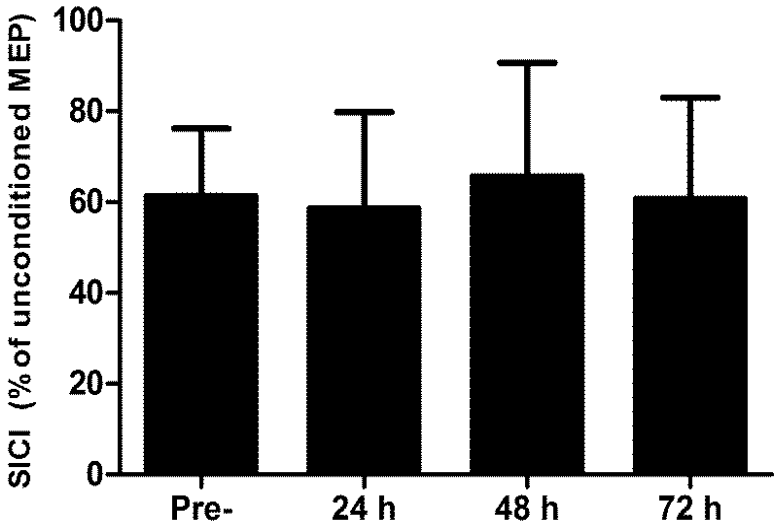
Results: neuromuscular fatigue



Significant differences indicated by * = $p < 0.05$, ** = $p < 0.01$ and *** = $p < 0.001$.

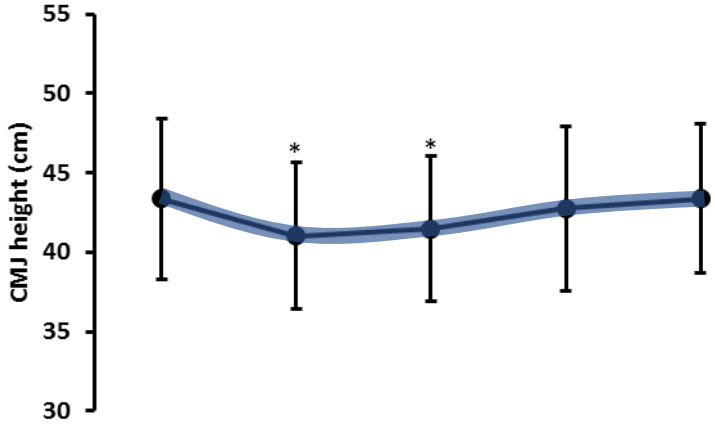
Results: corticospinal excitability and SICI

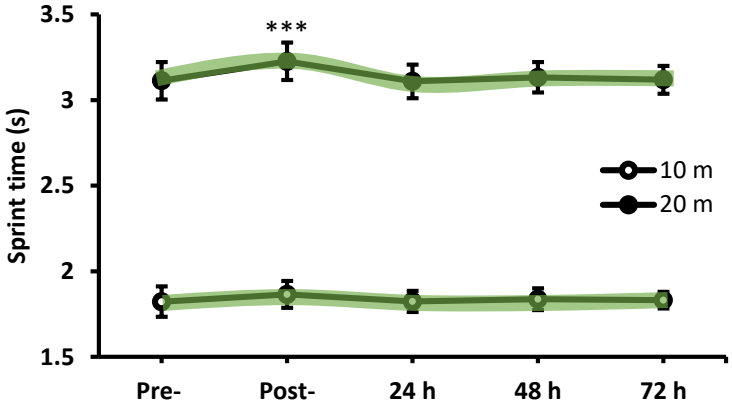


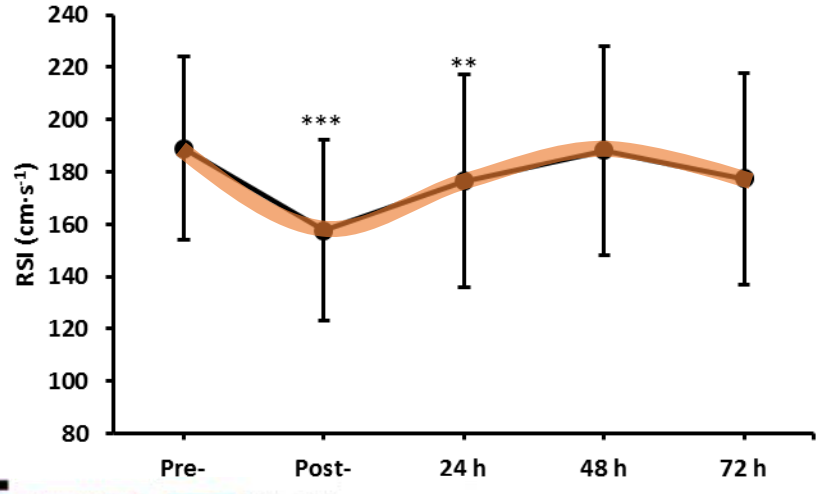


UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Results: physical measures



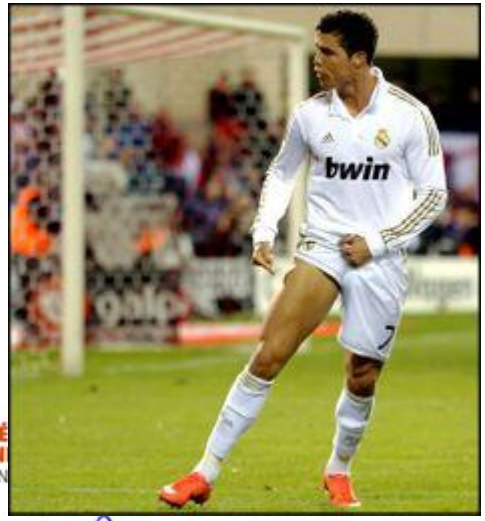




Significant differences indicated by * = $p < 0.05$, ** = $p < 0.01$ and *** = $p < 0.001$.

Conclusions

Football match-play elicits impairments in voluntary activation and contractile function which persist for 48 to 72 h post-match



Perturbations within the central nervous system contribute to the prolonged decrement in muscle strength post-match

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

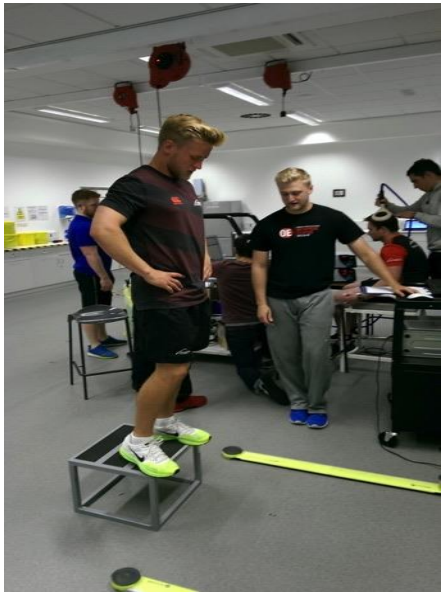
ActiFS Activité Physique Fatigue Santé

Slibm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

Conclusions

The similar decline and subsequent time-course of recovery of the drop-jump RSI test suggests that this might be appropriate tools to indirectly assess the recovery of neuromuscular function post-match



Perceptual fatigue persisted even after neuromuscular function had recovered

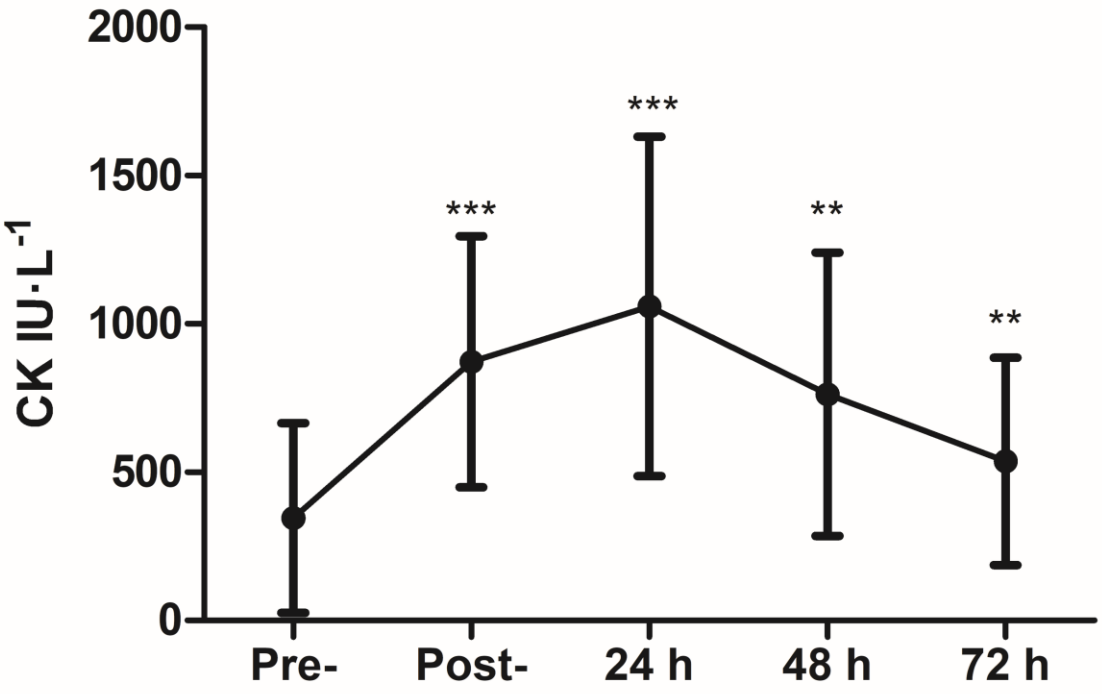
Northumbria University NEWCASTLE

Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?

1) Football match-play elicits considerable muscle damage

Biochemical i

António Ascen



se of

é del Ojo[b],

rmonal, muscle

abra, António Ascensão,

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

ActiFS Activité Physique Fatigue Santé

UNIVERSITÉ DE LYON

Slibm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?

2) Muscle damage causes prolonged impairments in contractile function (peak twitch force)

Reduction in peak twitch

Metabolic

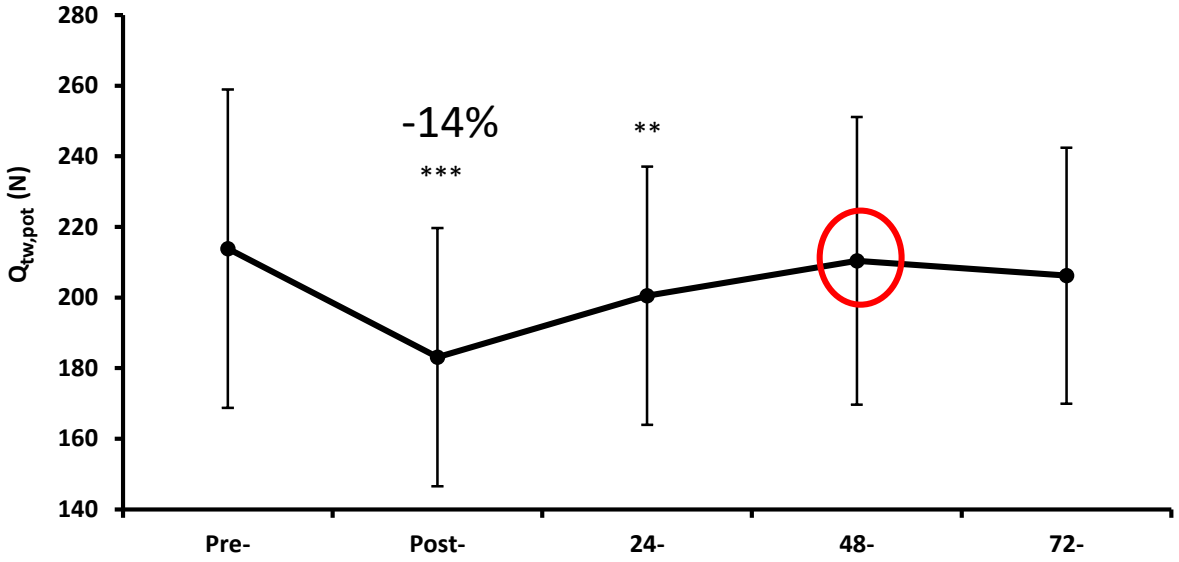
- Accumulation of Pi
- Accumulation of H^+ (maybe)
- Accumulation of ADP
- Rapid recovery

Mechanical

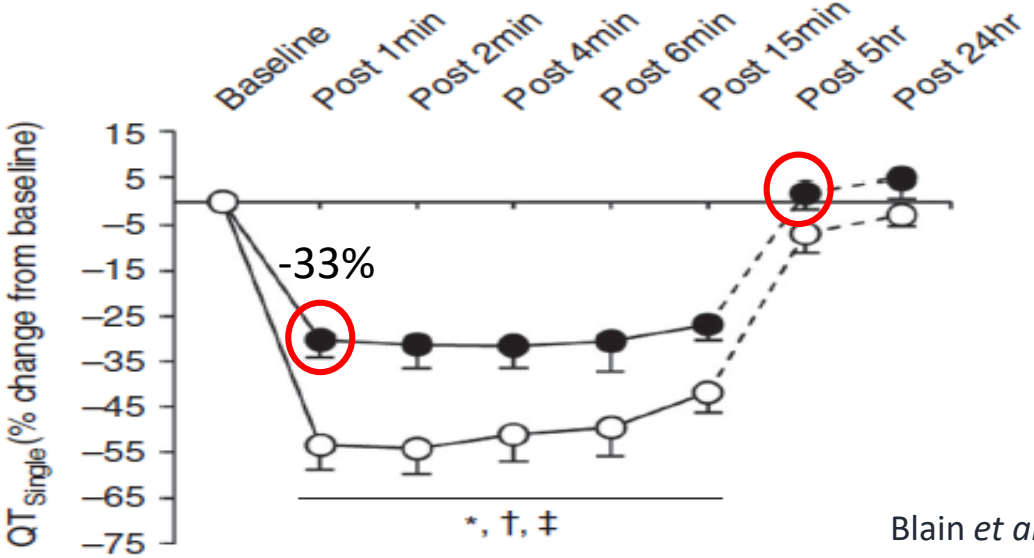
- Disorganisation of sarcomeres
- Damage to sarcoplasmic reticulum
- Impaired calcium release
- Slow recovery

Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?

Present study



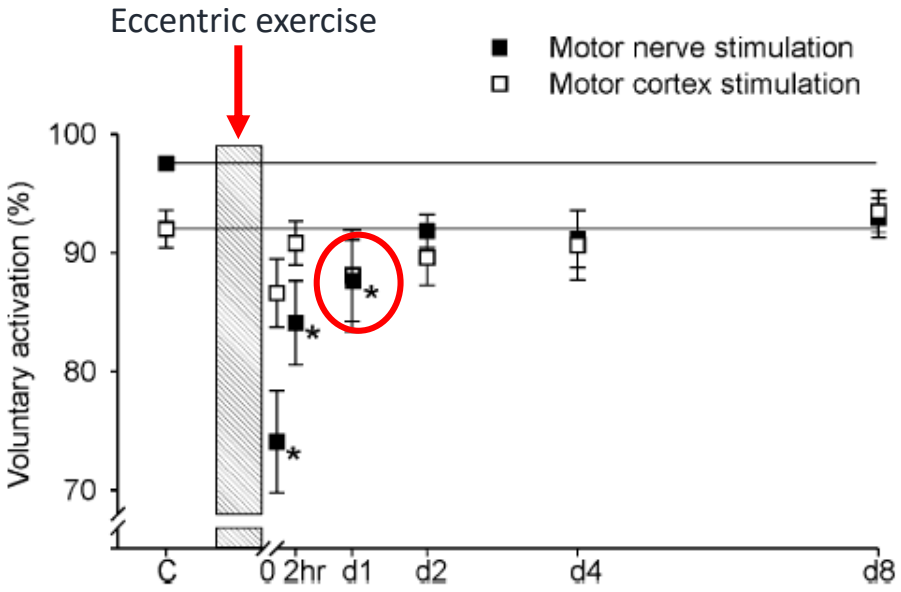
5km cycling time-trial

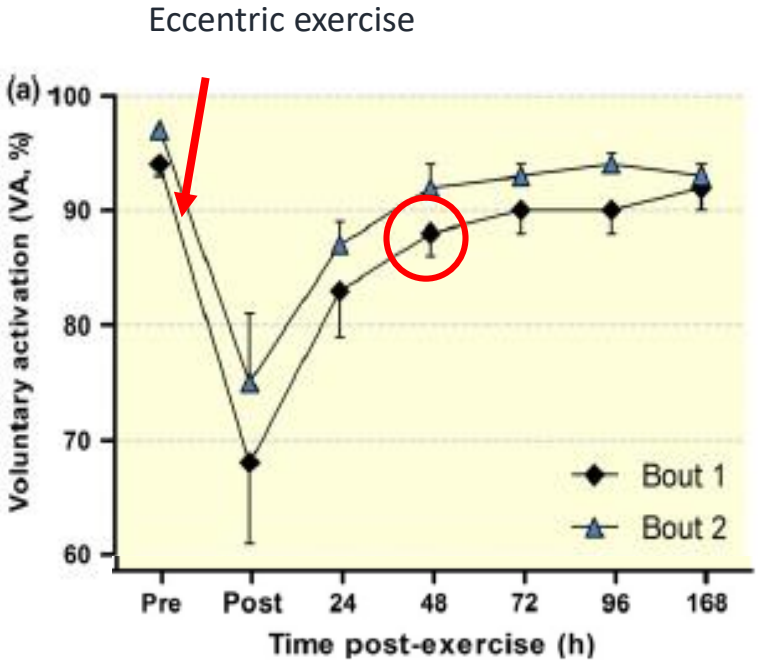


Blain *et al.*, 2016

Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?

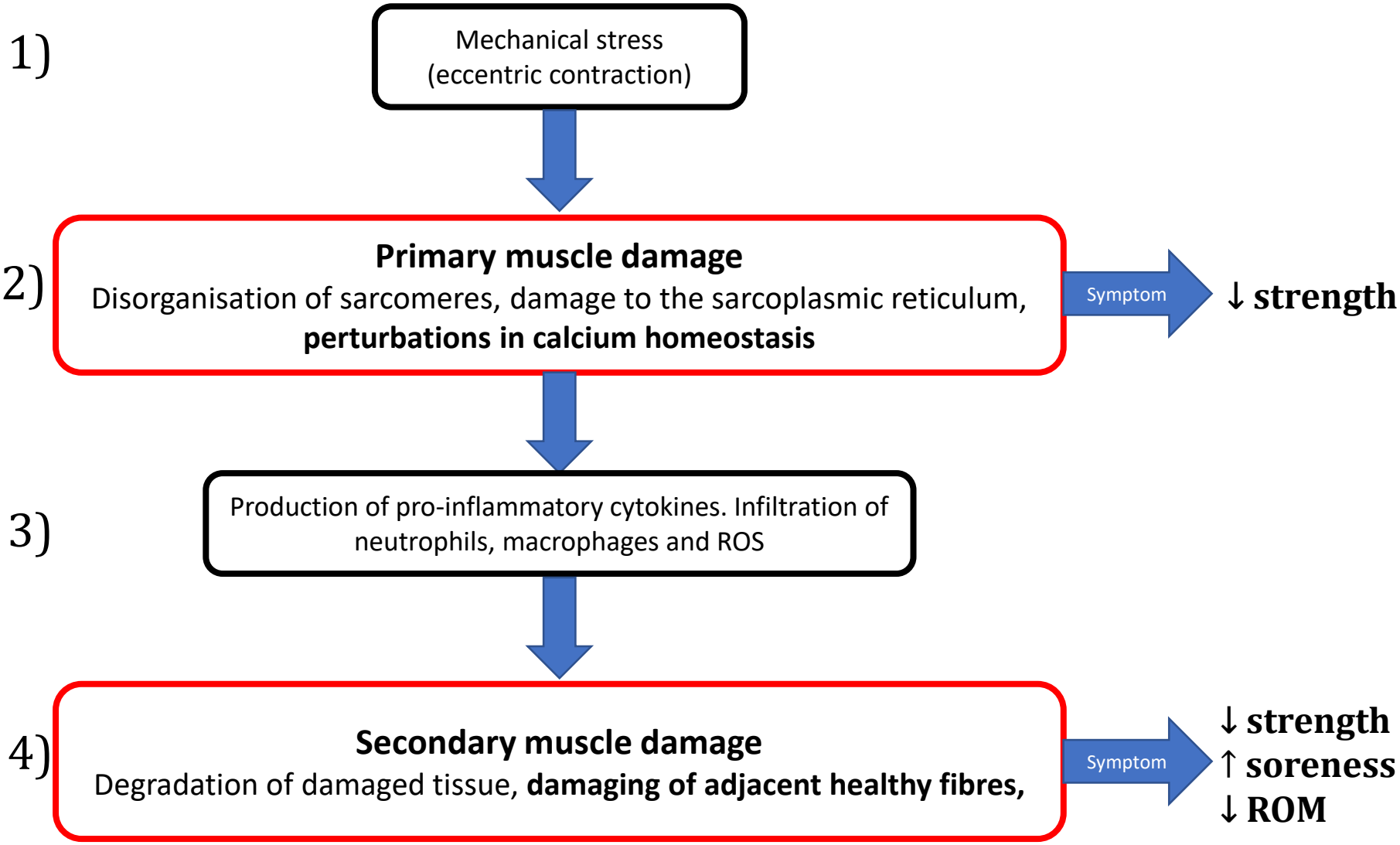
3) Muscle damage elicits prolonged reductions in voluntary activation





Prasartwuth *et al*., 2005; Goodall *et al*., 2018

Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?



Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?

3)

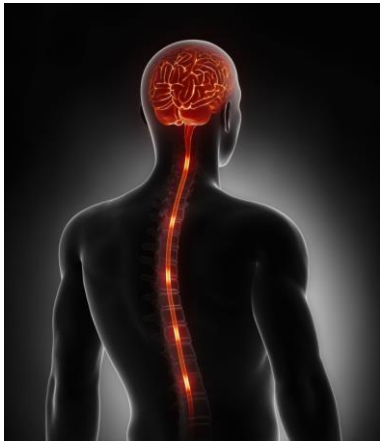
Production of pro-inflammatory cytokines. Infiltration of neutrophils, macrophages and ROS

Peripheral

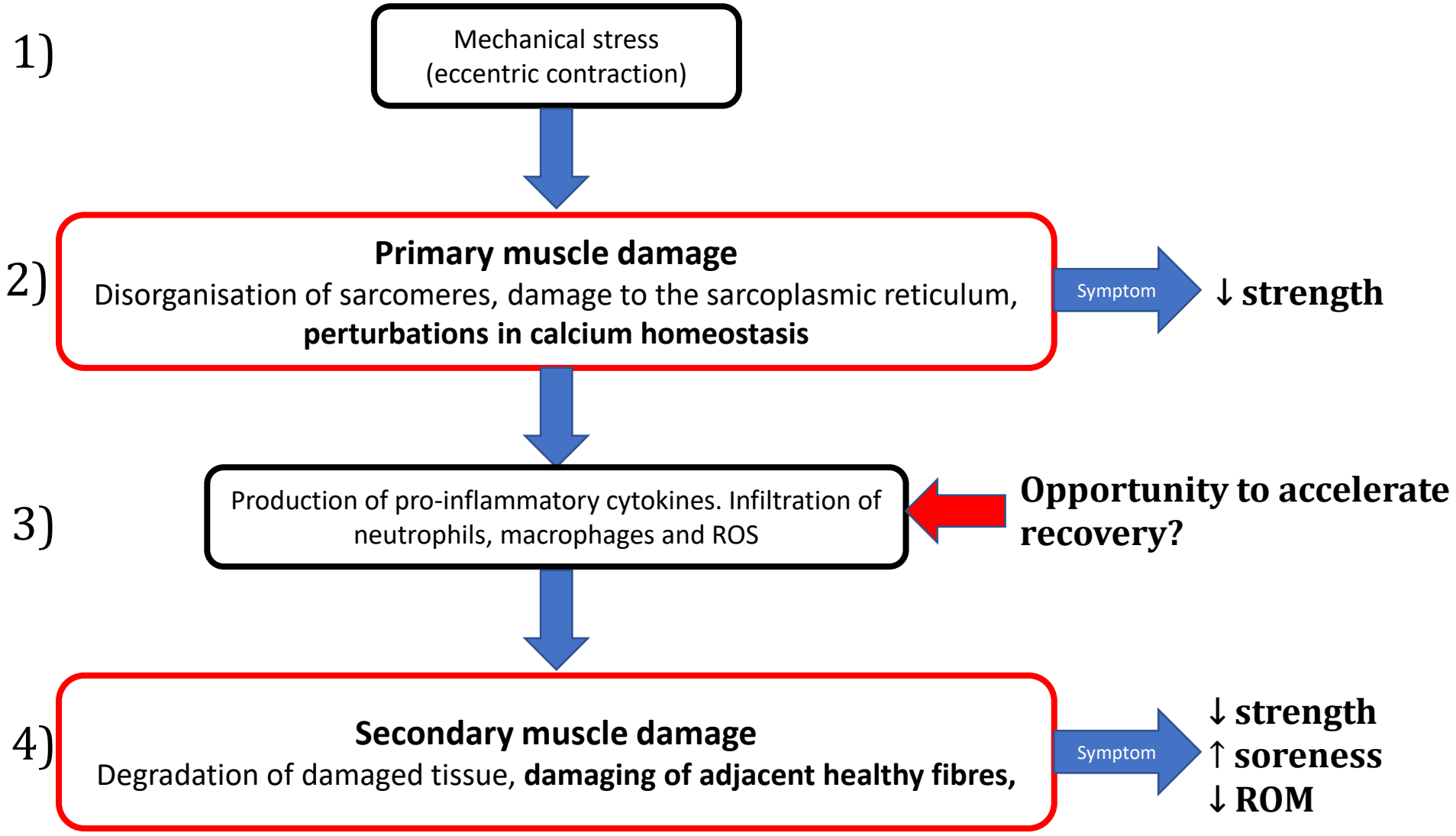
Damage to healthy fibres
ROS interfere with Ca^{2+} release and sensitivity
Possible contributor to reduction in Qtw,pot

Central

↑ firing of group III/IV afferents
↑ systemic inflammation
Possible contributor to reduction in VA



Prolonged impairments in VA and peak twitch force – mechanisms: muscle damage?



Effect of phase-change material on recovery of neuromuscular function following competitive football match-play

Brownstein *et al.,* (under review)

Phase change material vs traditional cryotherapy

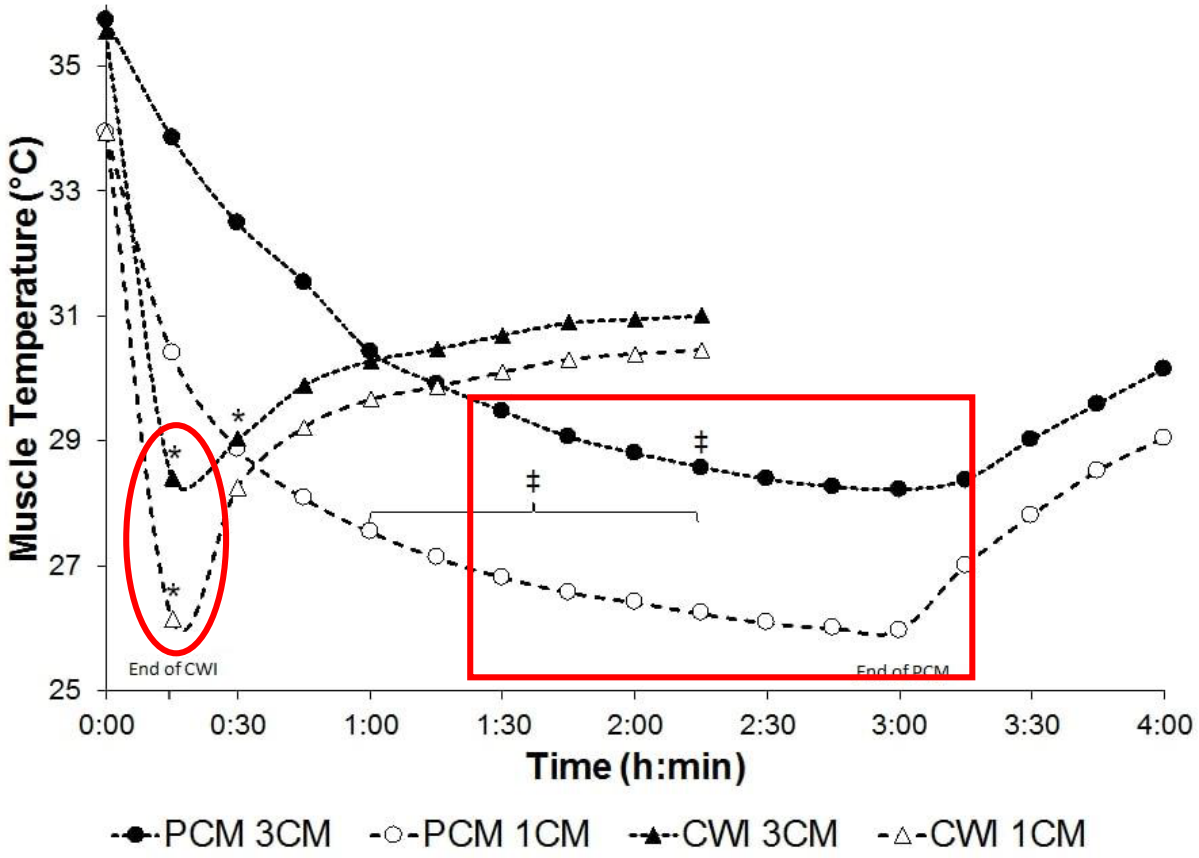
Cold-water immersion

- Brief cooling stimulus (typically 10-15 minutes)
- Thermal discomfort
- Logistically impractical (e.g. away fixtures)

Phase change material

- Prolonged cooling stimulus
- Lower thermal discomfort
- Easy to implement

PCM: prolonged decrease in muscle temperature



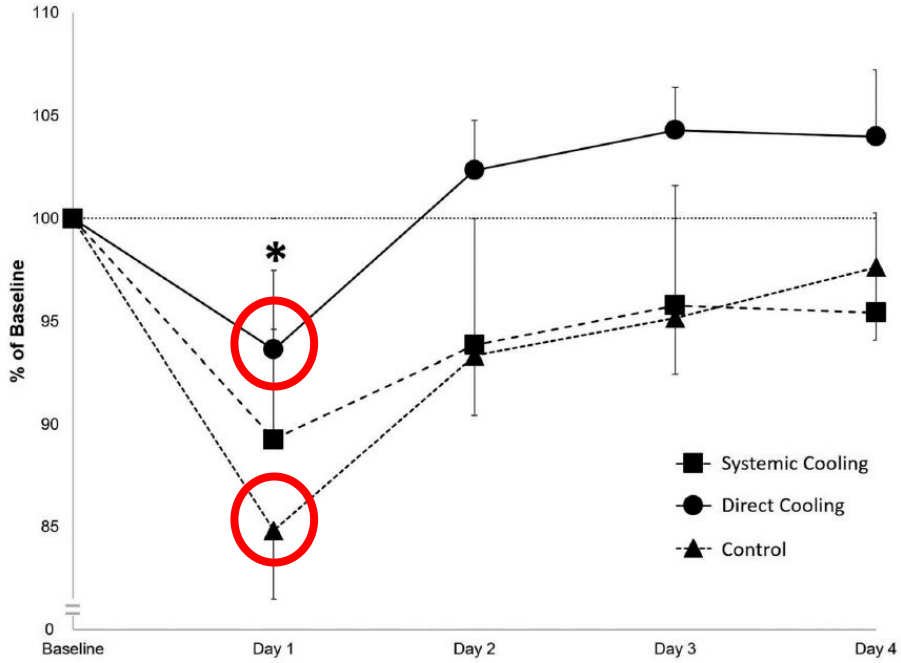
Kwiecien *et al*., (2019)

PCM: recovery of muscle function

JOURNAL OF SPORTS SCIENCES, 2017
http://dx.doi.org/10.1080/02640414.2017.1312492

The efficacy of cooling with phase change material for the treatment of exercise-induced muscle damage: pilot study

Susan Y. Kwiecien[a,b], Malachy P. McHugh[a] and Glyn Howatson[b,c]



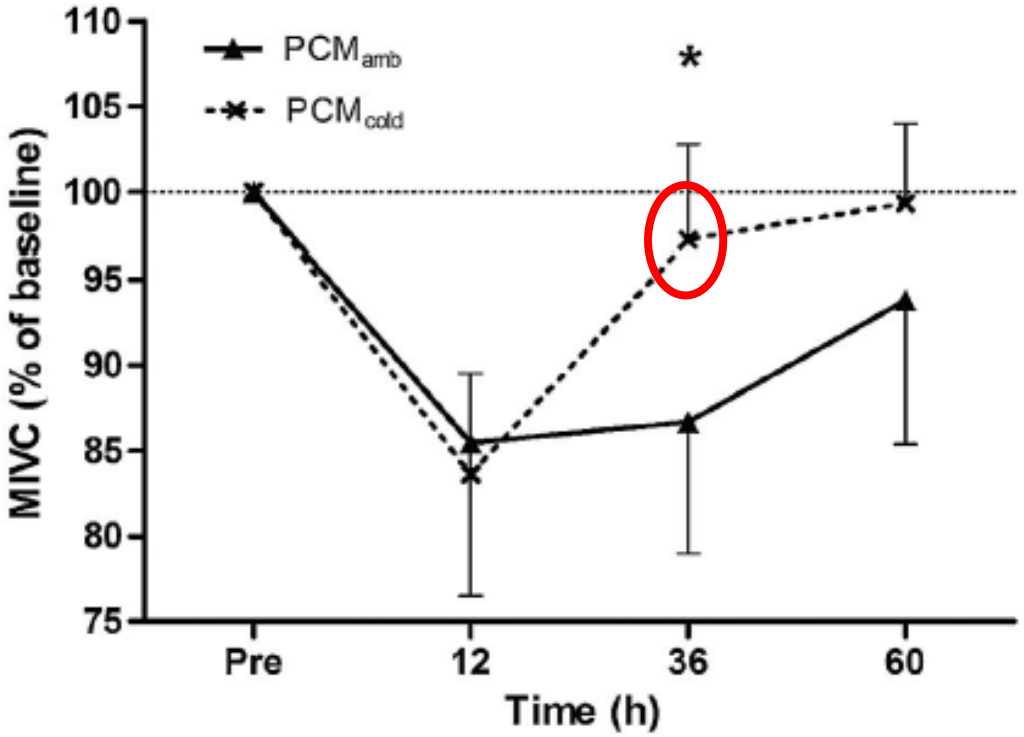
PCM: recovery of muscle function

International Journal of Sports Physiology and Performance, 2018, 13, 584-589
https://doi.org/10.1123/ijspp.2017-0334

Human Kinetics
ORIGINAL INVESTIGATION

Cryotherapy Reinvented: Application of Phase Change Material for Recovery in Elite Soccer

Tom Clifford, Will Abbott, Susan Y. Kwiecien, Glyn Howatson, and Malachy P. McHugh



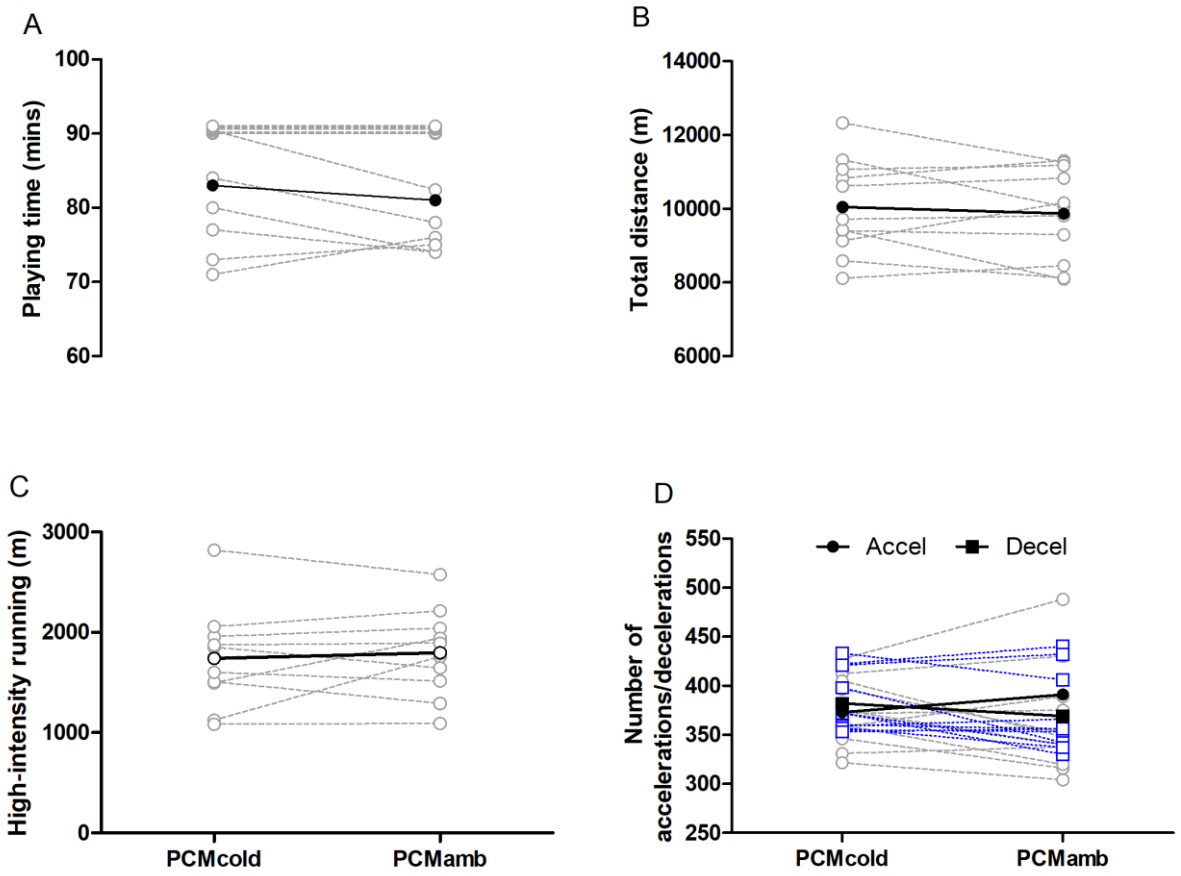
Methods

- 11 male semi-professional footballers (level 8 of EFL)
- Players studied over two 90-minute matches. Players wore either frozen PCM (PCM_{cold}) or unfrozen PCM (PCM_{amb}) for 3 h post-match.

- Measures taken pre-, 24, 48 & 72 h post-match
- Neuromuscular fatigue measures:
  - Maximal voluntary contraction
  - Voluntary activation (motor nerve and motor cortical stimulation)
  - Potentiated twitch force
- Physical measures:
  - CMJ
  - Drop-jump RSI

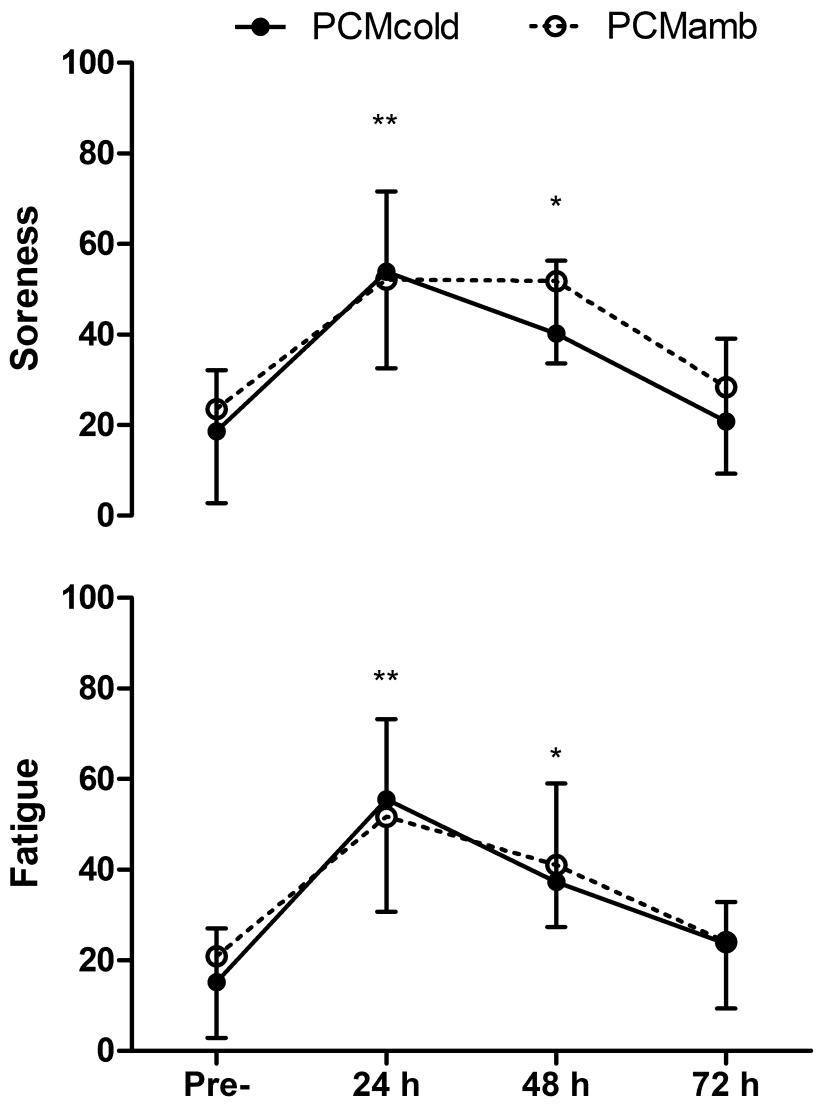
umbria
University
NEWCASTLE

Results: match-demands

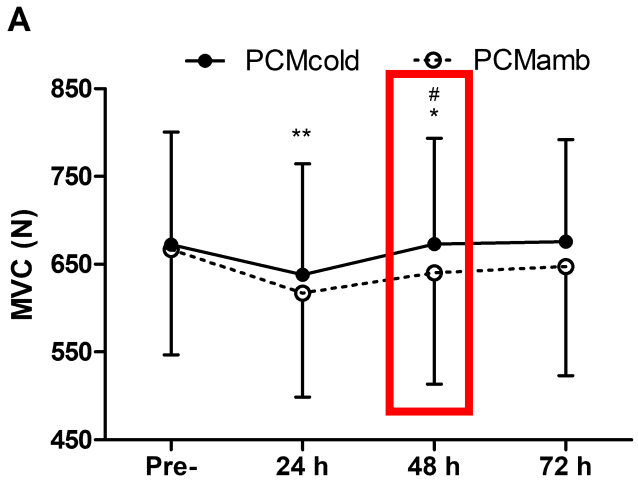


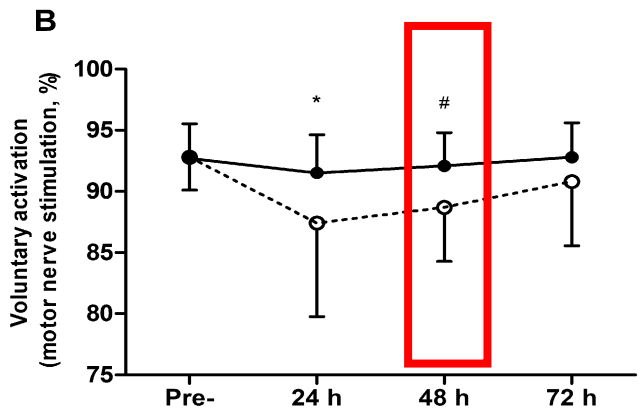
UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique, Fatigue, Santé
Slibm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

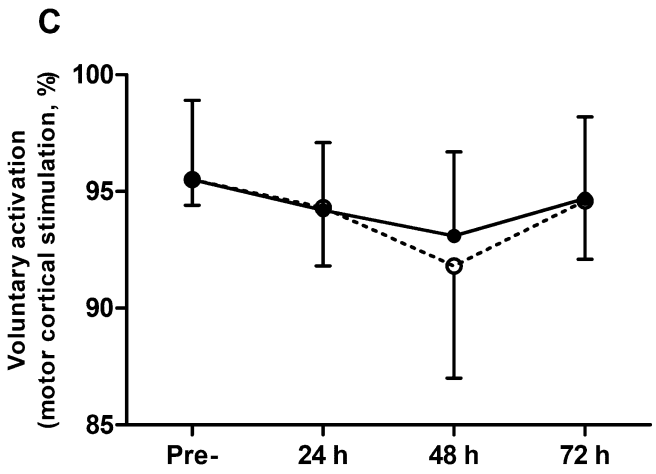
Results: soreness and fatigue

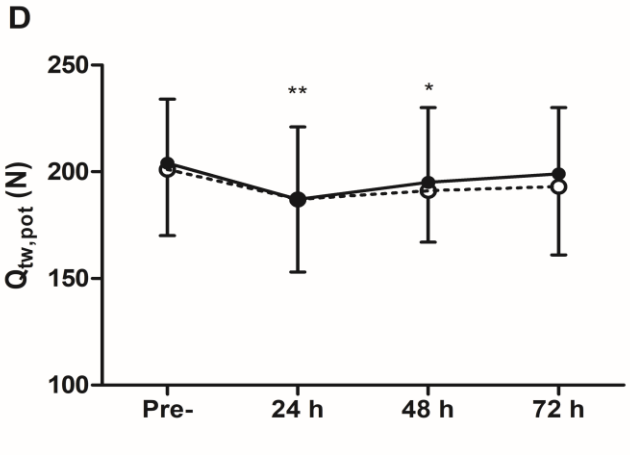


Results: neuromuscular responses







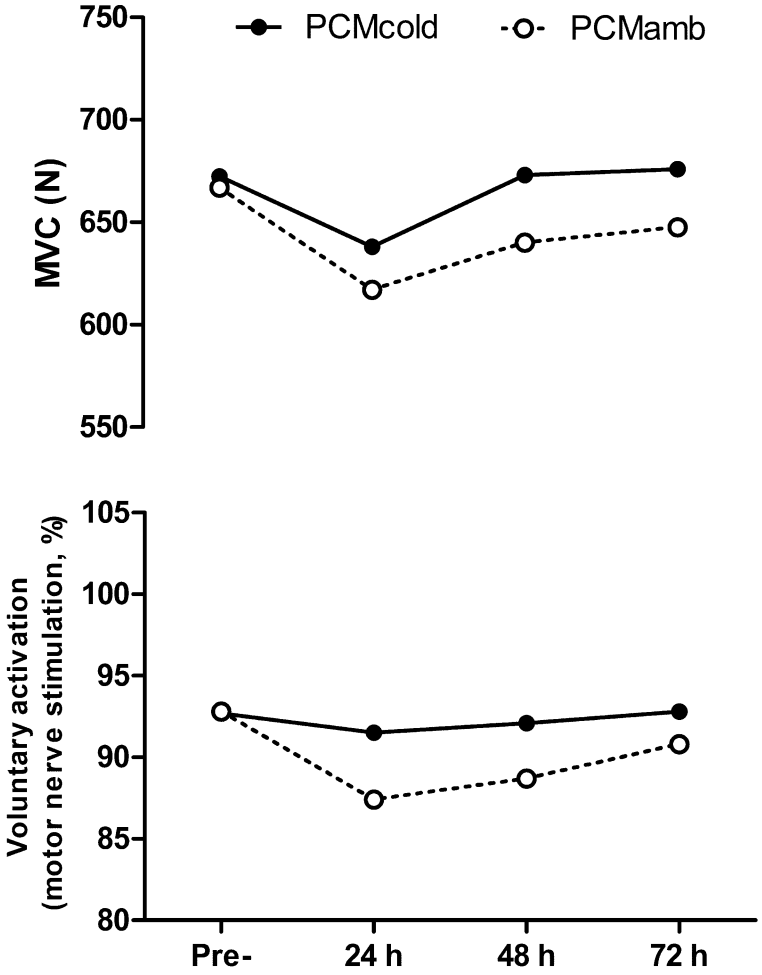


Activité Physique Fatigue Santé

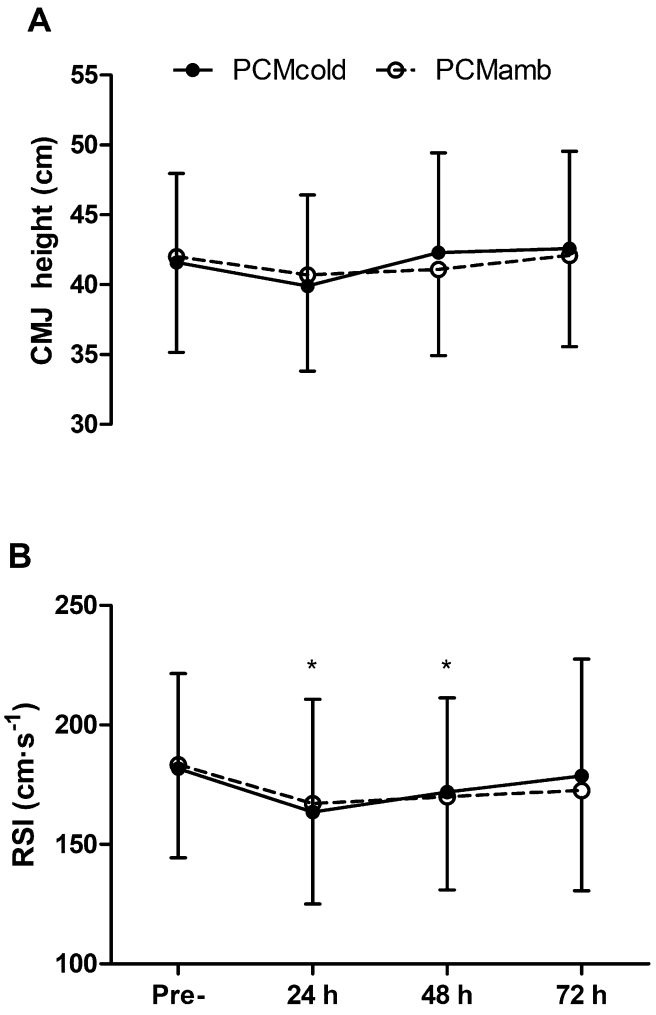
libm Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE

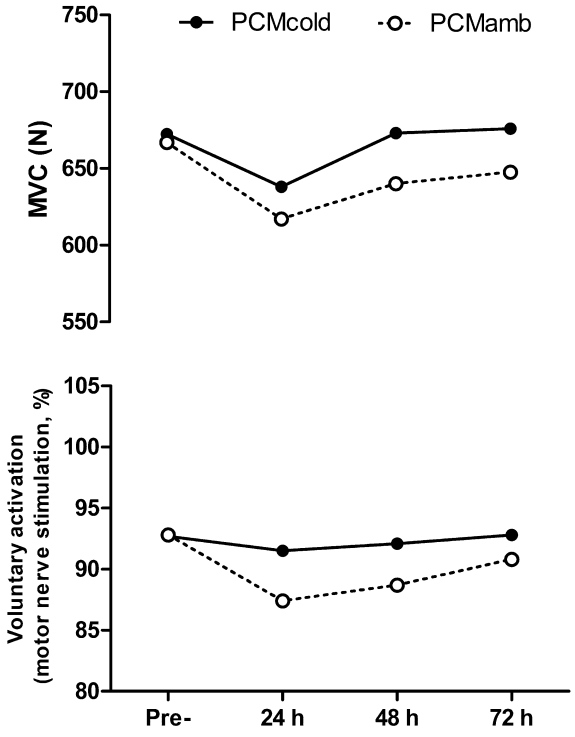
Results: neuromuscular responses

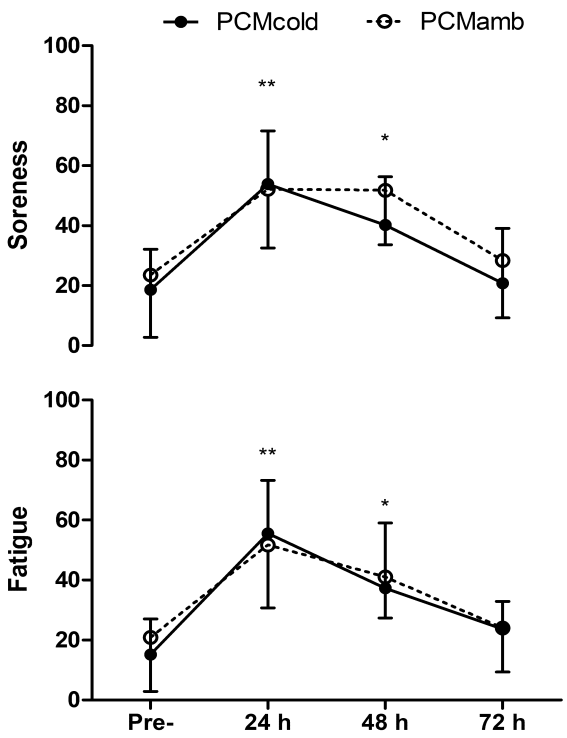


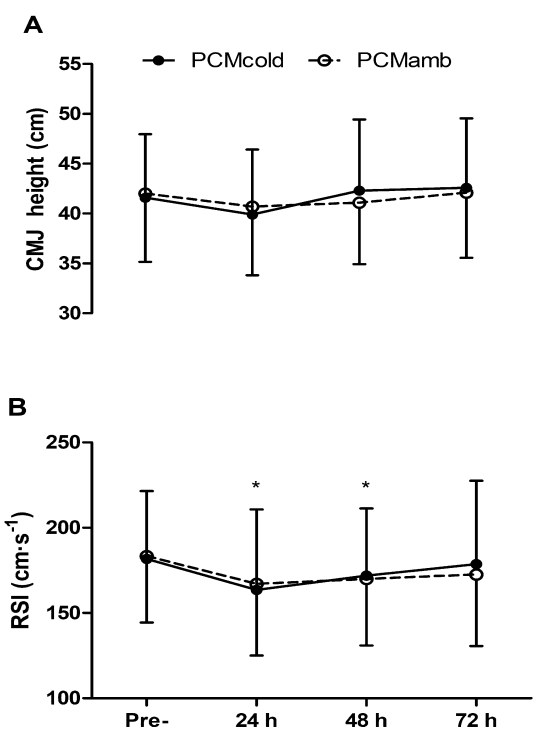
Results: physical function



Conclusions



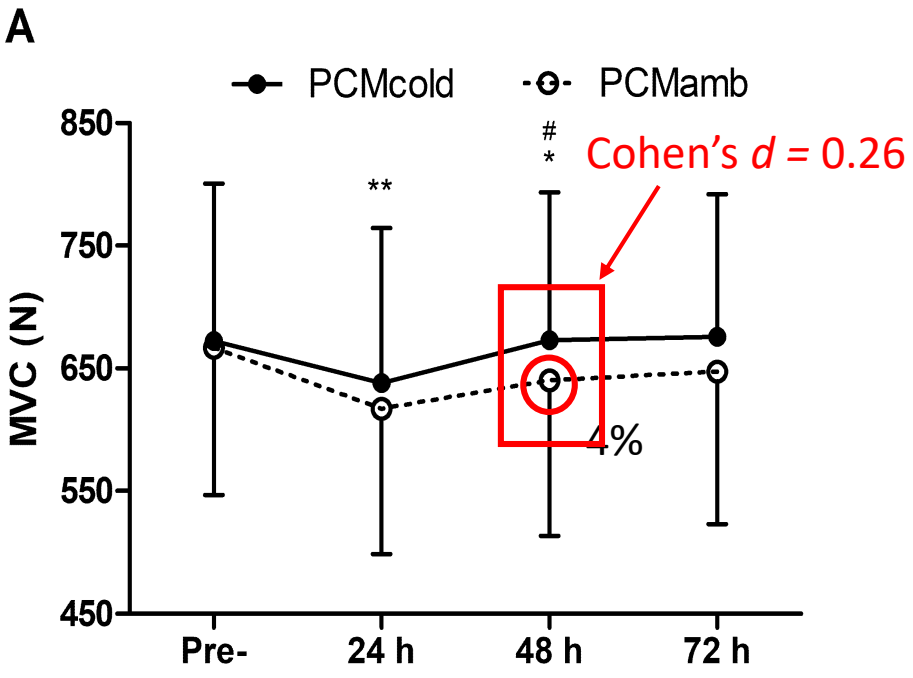




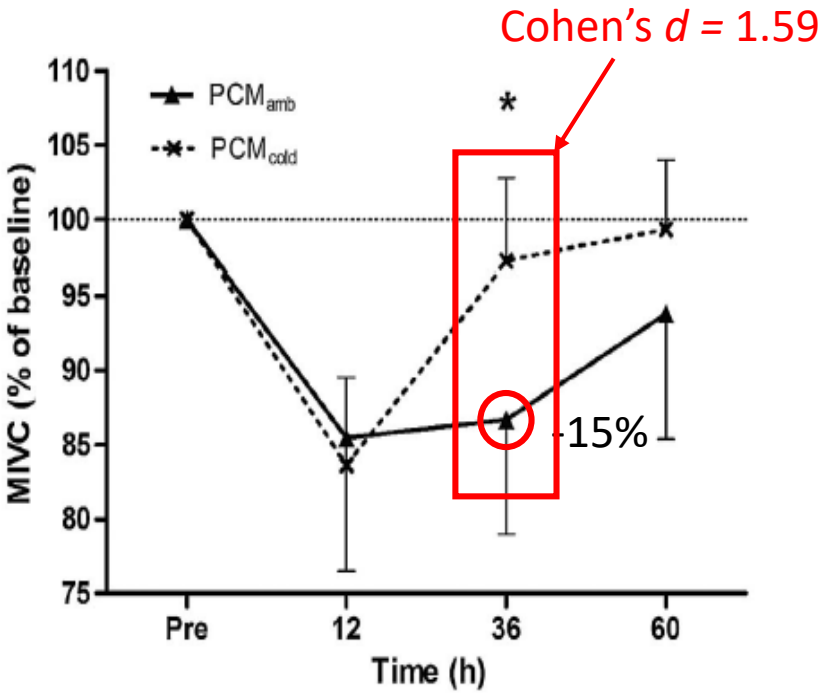
UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
Slibm
Northumbria University NEWCASTLE

Conclusions

Present study



Clifford et al. (2018)



UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Practical implications: training scheduling

Practical implications: training scheduling

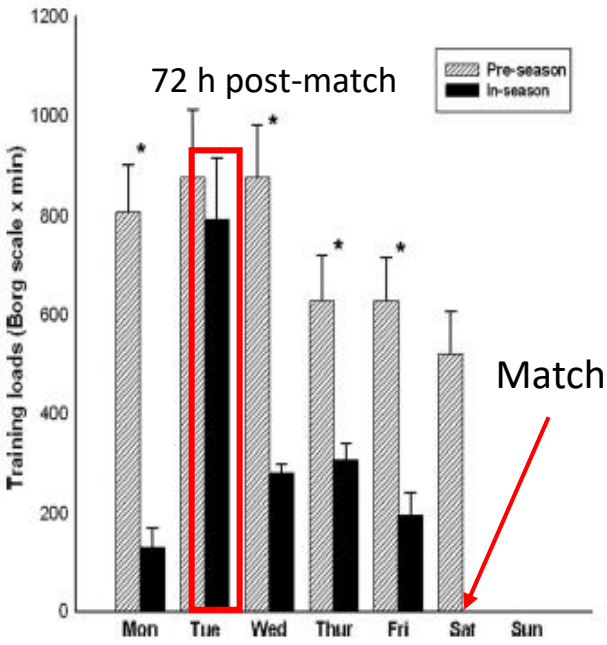
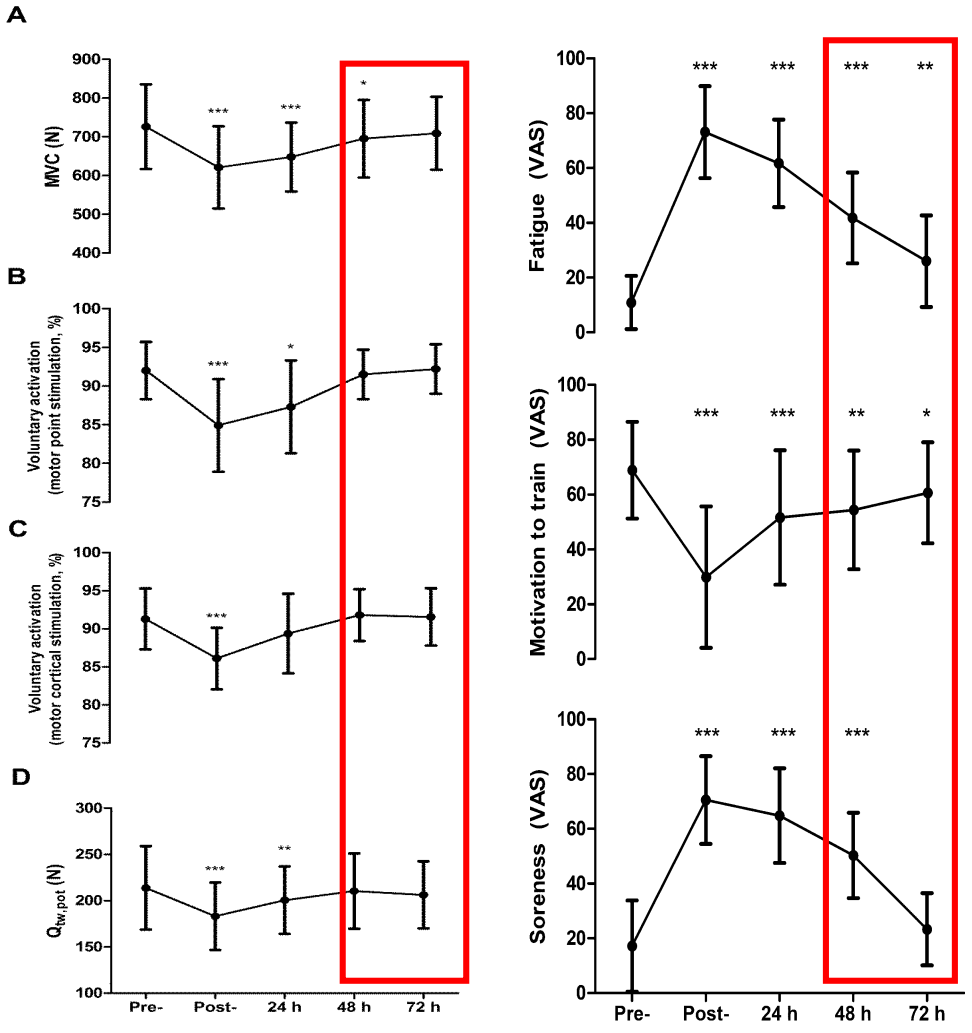
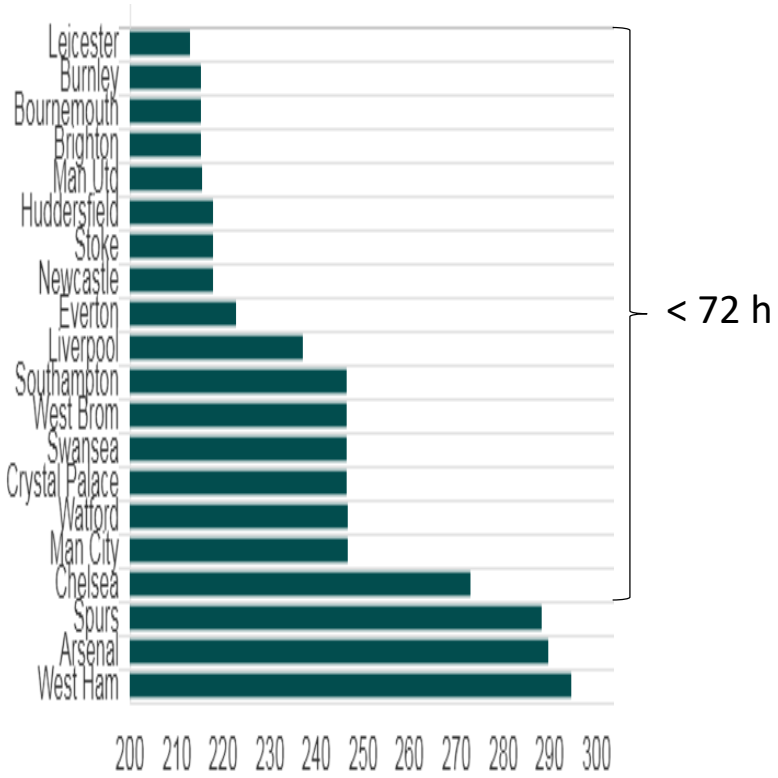


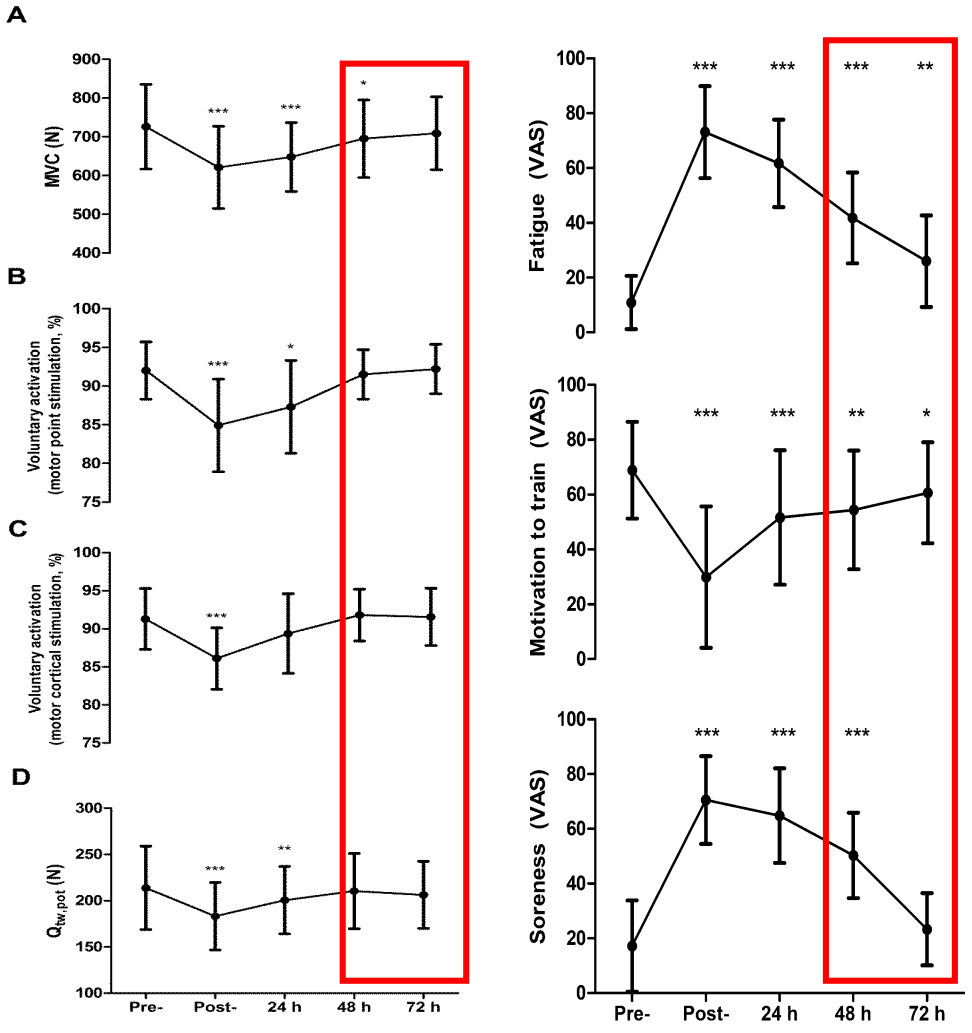
Figure 2. Representation of the weekly training loads calculated using rating of perceived exertion during the pre-season and in-season periods. *$P < 0.05$, significant difference between the pre-season and in-season periods.



Practical implications: squad rotation

Practical implications: squad rotation





UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
Slibm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Practical implications: recovery strategies

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE
IDEX LYON UNIVERSITÉ DE LYON
ActiFS Activité Physique Fatigue Santé
libm Laboratoire Interuniversitaire de Biologie de la Motricité
Northumbria University NEWCASTLE

Merci, désolé je n'ai pas pu présenter en français !

Dr. Kevin Thomas

Dr. Stuart Goodall

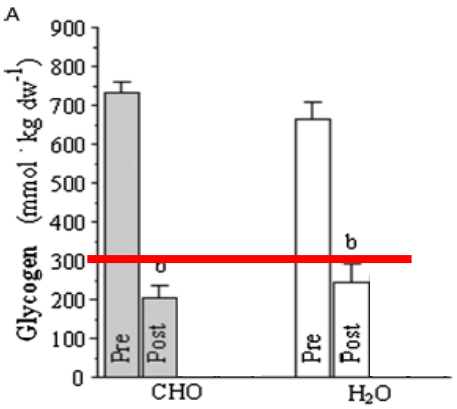
Prof. Glyn Howatson

Northumbria University
NEWCASTLE

Prolonged impairments in VA and peak twitch force – mechanisms: Glycogen depletion?

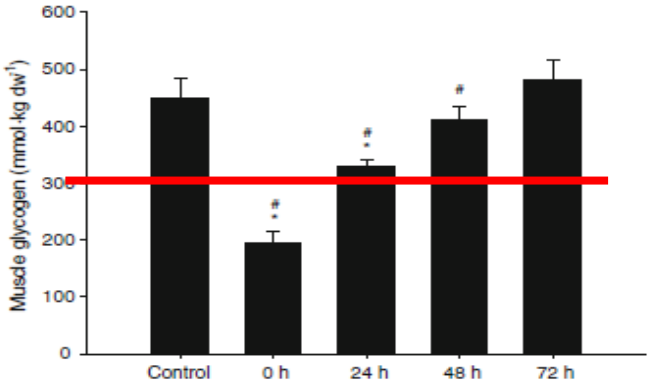
Muscle Glycogen Content Modifies SR Ca^{2+} Release Rate in Elite Endurance Athletes

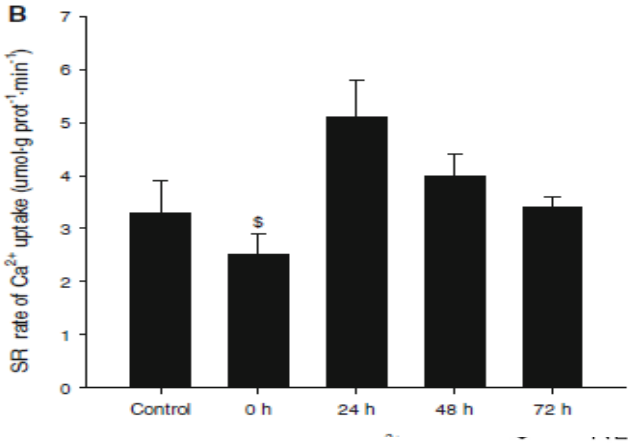
KASPER DEGN GEJL[1], LARS GRØNDAHL HVID[1], ULRIK FRANDSEN[1], KURT JENSEN[1,2], KENT SAHLIN[3], and NIELS ØRTENBLAD[1,2]



Maximal voluntary contraction force, SR function and glycogen resynthesis during the first 72 h after a high-level competitive soccer game

Peter Krustrup · Niels Ørtenblad · Joachim Nielsen · Lars Nybo · Thomas P. Gunnarsson · F. Marcello Iaia · Klavs Madsen · Francis Stephens · Paul Greenhaff · Jens Bangsbo





rthumbria
iversity
VCASTLE

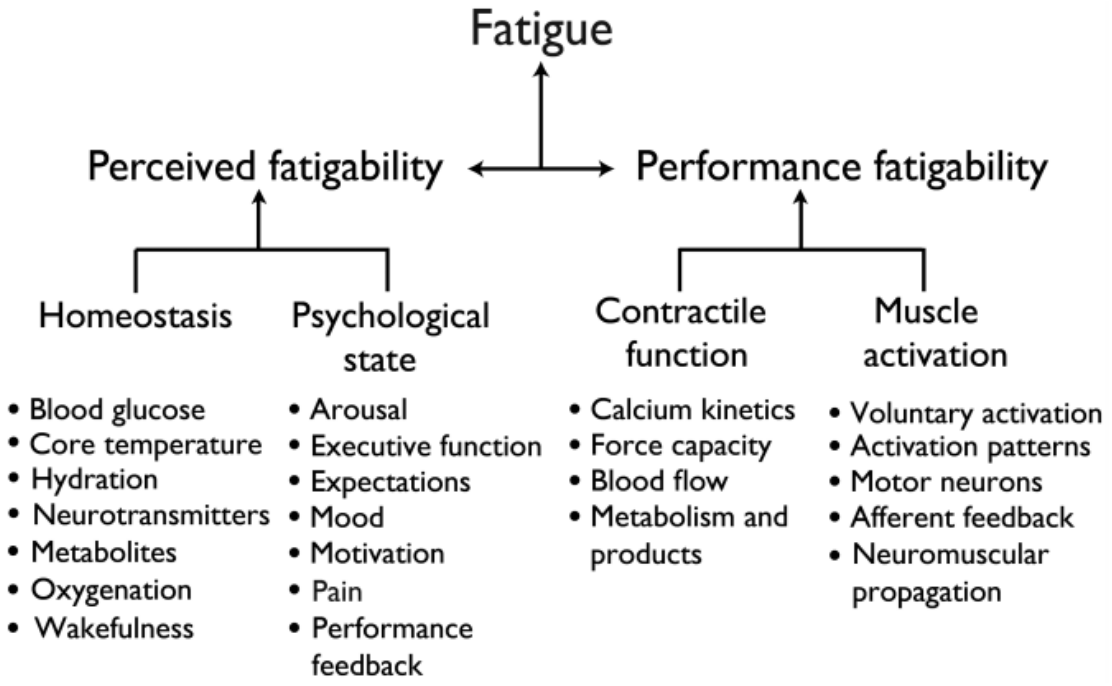
	Present study	Thomas *et al*.(2017)
MVC		
pre-post	−14 ± 9%	−16 + 8%
pre-24	−11 ± 6%	−10 + 6%
pre-48	−4 ± 6%	−7 + 5%
pre-72	−2 + 9%	−3 + 4%
$Q_{tw,Pot}$		
pre-post	−14 ± 6%	−14 ± 10%
pre-24	−6 ± 6%	−13 ± 5%
pre-48	−1 ± 4%	−9 ± 6%
pre-72	−3 ± 7%	−5 ± 6%
VA		
pre-post	−8 ± 6%	−9 ± 4%
pre-24	−5 ± 5%	−4 ± 2%
pre-48	0 ± 4%	−2 ± 3%
pre-72	0 ± 3%	−2 ± 4%
CVA		
pre-post	−6 ± 4%	−11 ± 6%
pre-24	−2 ± 5%	−3 ± 3%
pre-48	−1 ± 5%	0 ± 4%
pre-72	0 ± 5%	0 ± 3%

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

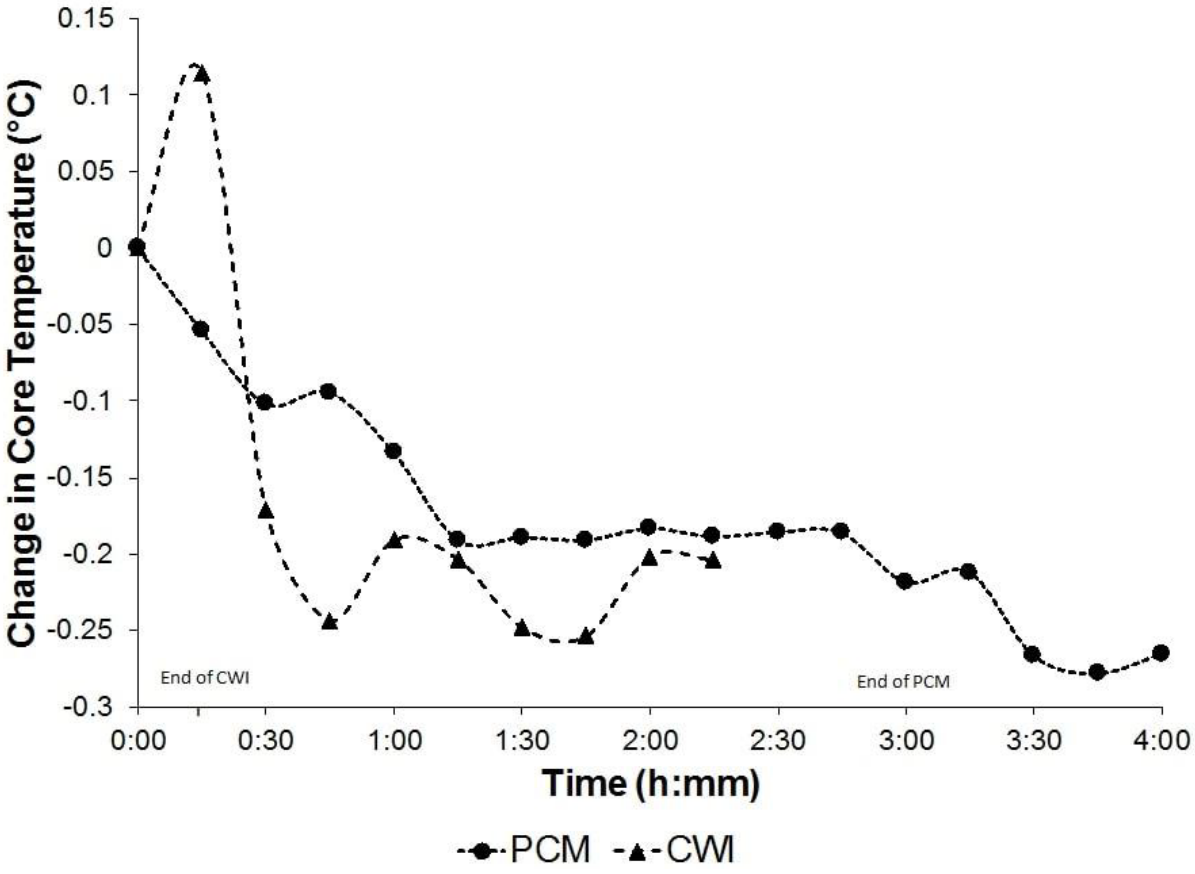
ActiFS Activité Physique, Fatigue, Santé

IIBM Laboratoire Interuniversitaire de Biologie de la Motricité

Northumbria University NEWCASTLE



PCM: prolonged decrease in muscle temperature



Kwiecien *et al*., (2019)

Neuromuscular impairment throughout match-play