AUT SPORTS PERFORMANCE
RESEARCH INSTITUTE NEW ZEALAND

Priming for Optimal Performance

What, why, who and when…….?

Professor Andrew Kilding, AUT University, New Zealand

AUT RESEARCH & INNOVATION

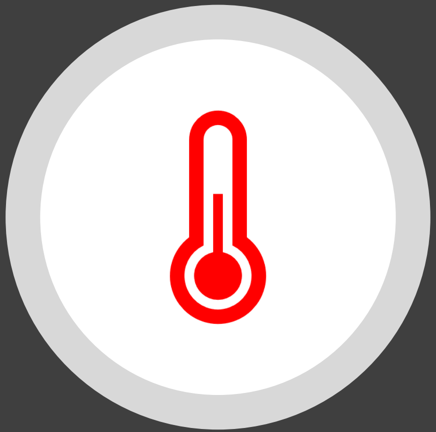
SINGAPORE SPORT INSTITUTE

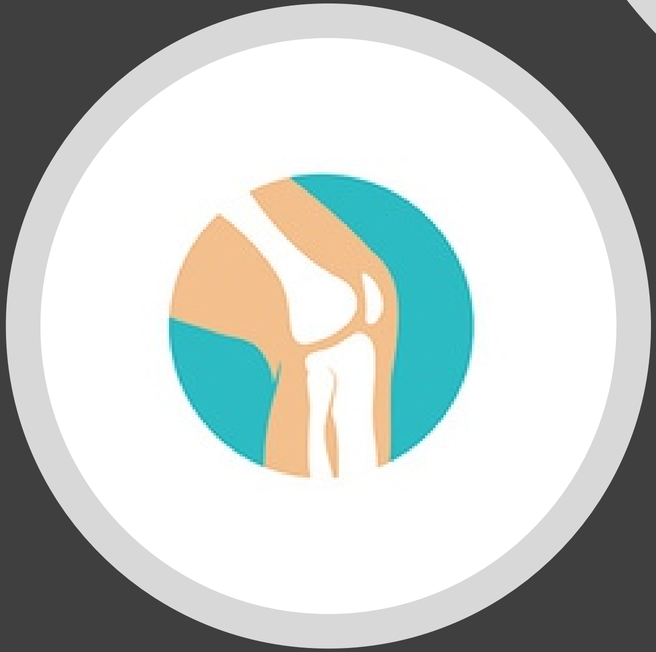
ASIA

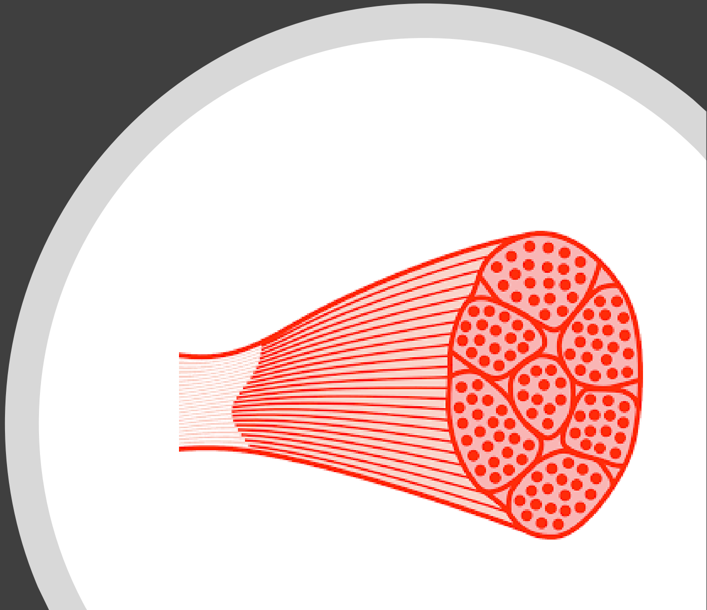
Singapore Sport Science Symposium 2018 and 3rd Association of Sports Institutes in Asia (ASIA) Congress, 7 – 9 November, 2018

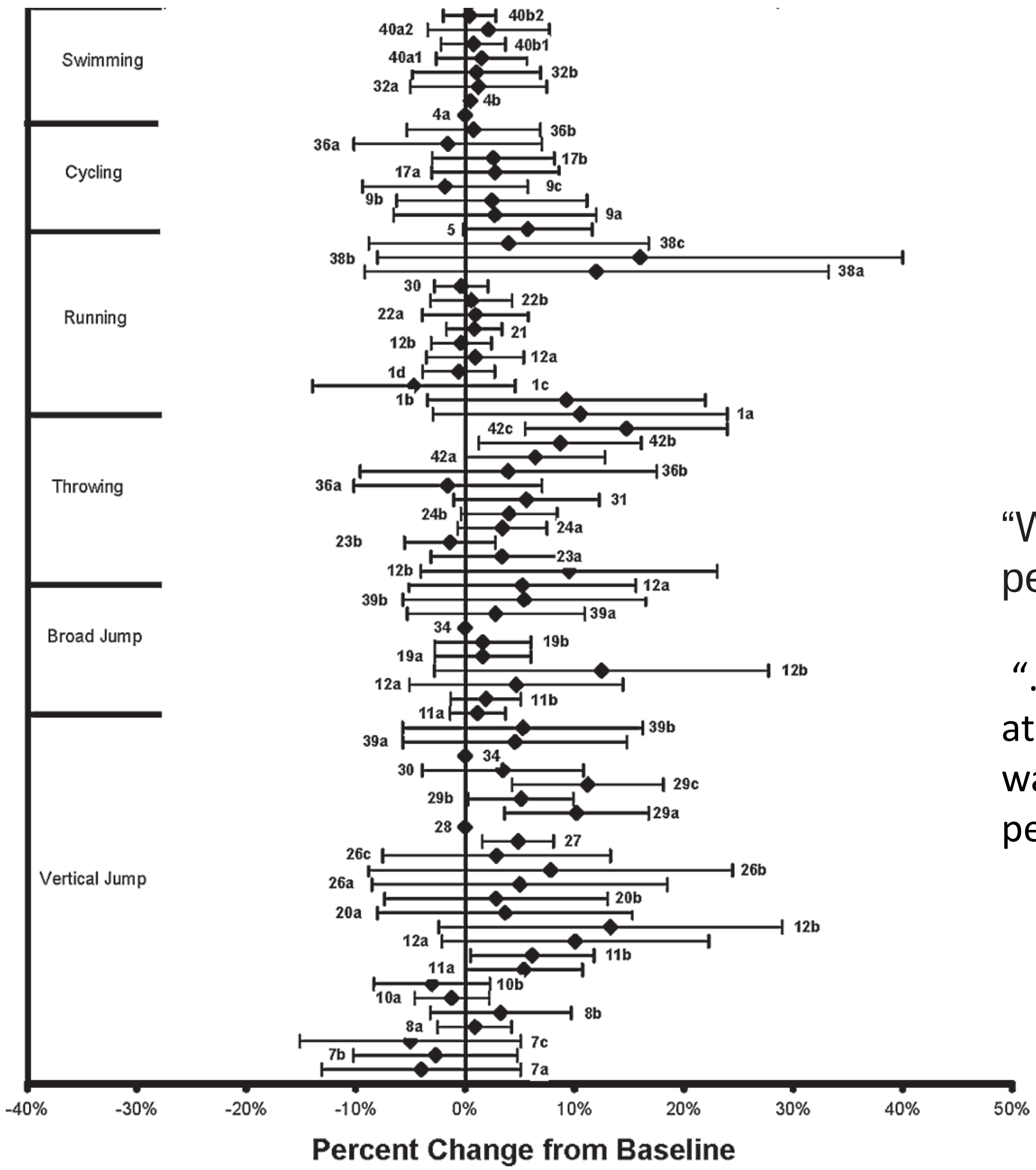
Warm-up, priming, potentiation……………

- 1950s - Early/original performance studies effect or no effect
- Mid-late 1990s – mechanistic focus
- 2000 to date – applied, refinement, sport specific, optimisation









“Warm-up was shown to improve performance in 79% of the criterions examined”.

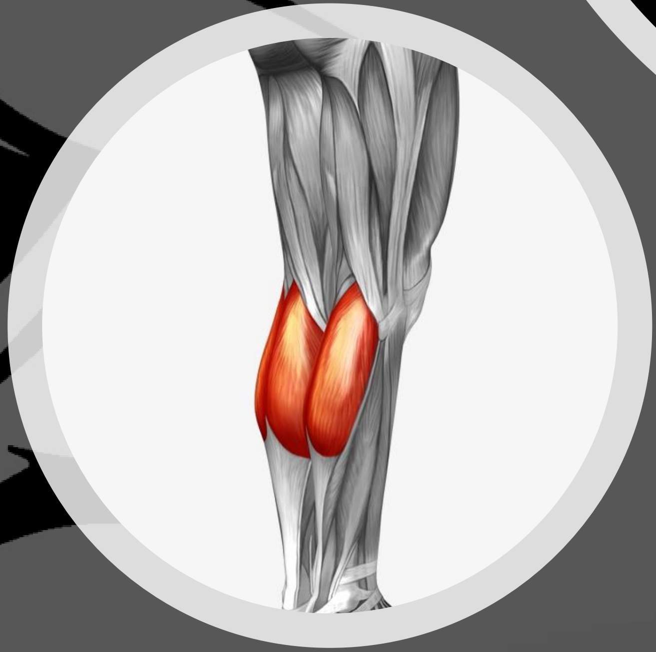
“…………..3% showing no change at all in performance, and 17% finding that the warm-up had a negative impact upon the performance”.

Fradkin et al. (2010) JSCR

Multi-system approach to 'priming'

<u>Peripheral</u>
Muscle,
Tendon

<u>Central</u>
Heart,
Respiratory,
Brain,
Endocrine



Music and Testosterone Fukui & Yamashita (2003)

♂

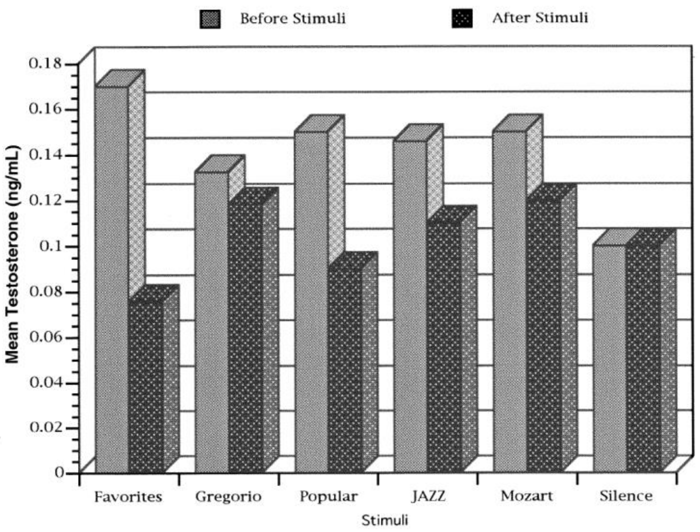


FIGURE 1. Testosterone levels of 35 male subjects sampled at 30-minute intervals. ANOVA revealed that the main effect of the stimuli was significant ($p < 0.0001$).

♀

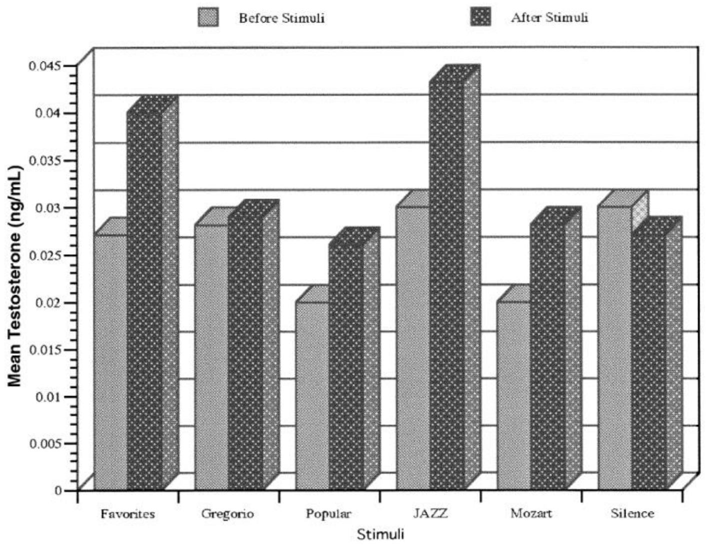


FIGURE 2. Testosterone levels of 35 female subjects sampled at 30-minute invervals. ANOVA shows that the main effect for stimuli was significant ($p < 0.0001$).

Priming?



What's in the Priming Toolbox?

Factors influencing priming decisions

EVENT DEMANDS: DURATION, INTENSITY

EVENT TIMING, RULES & CONSTRAINTS

ENVIRONMENTAL CONDITIONS

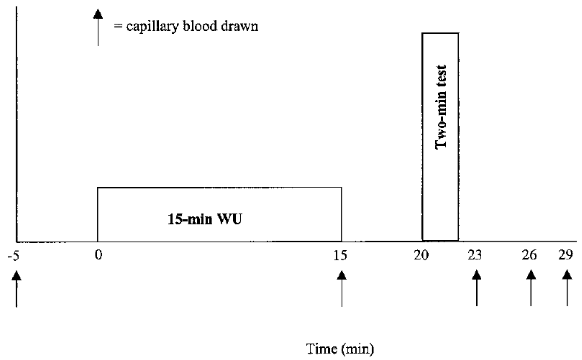
FACILITIES / EQUIP

ATHLETE +/-

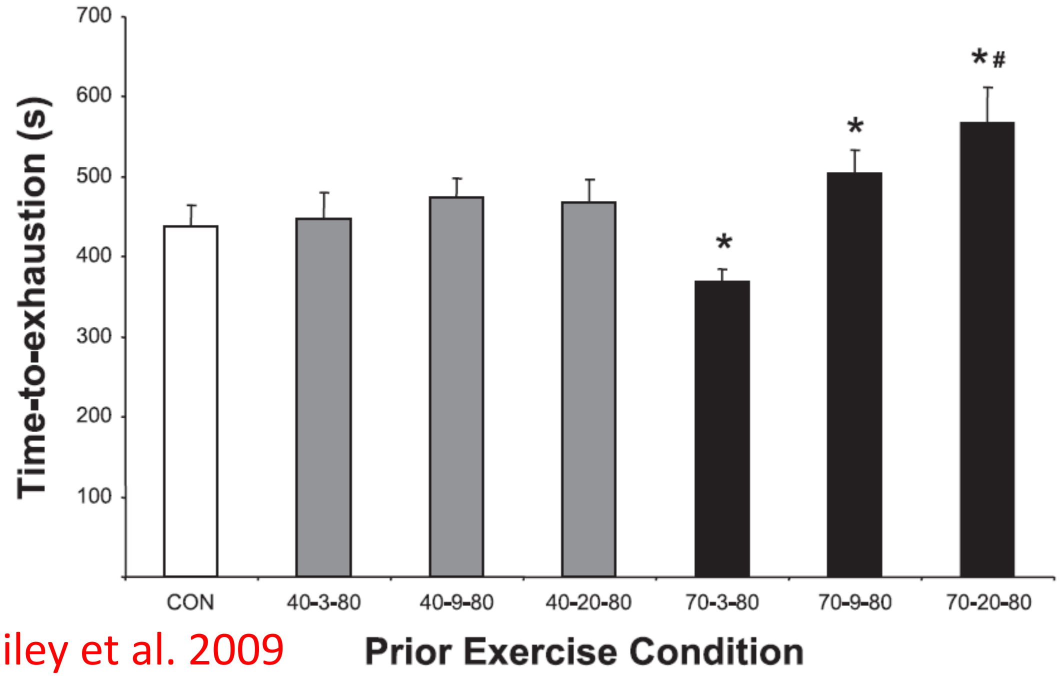
ATHLETE/COACH PREFERENCE (HISTORICAL?)

“Metabolic” Priming & Physiology

- Momentum started ~1990s….
- Mechanistic focus – PCr and VO2 kinetics (“Prior exercise” studies)
- Bishop et al. – “Warm up” studies (early 2000s)
- Bailey et al. (2009) – >9 minutes “optimal” after HVY (70%Δ) exercise



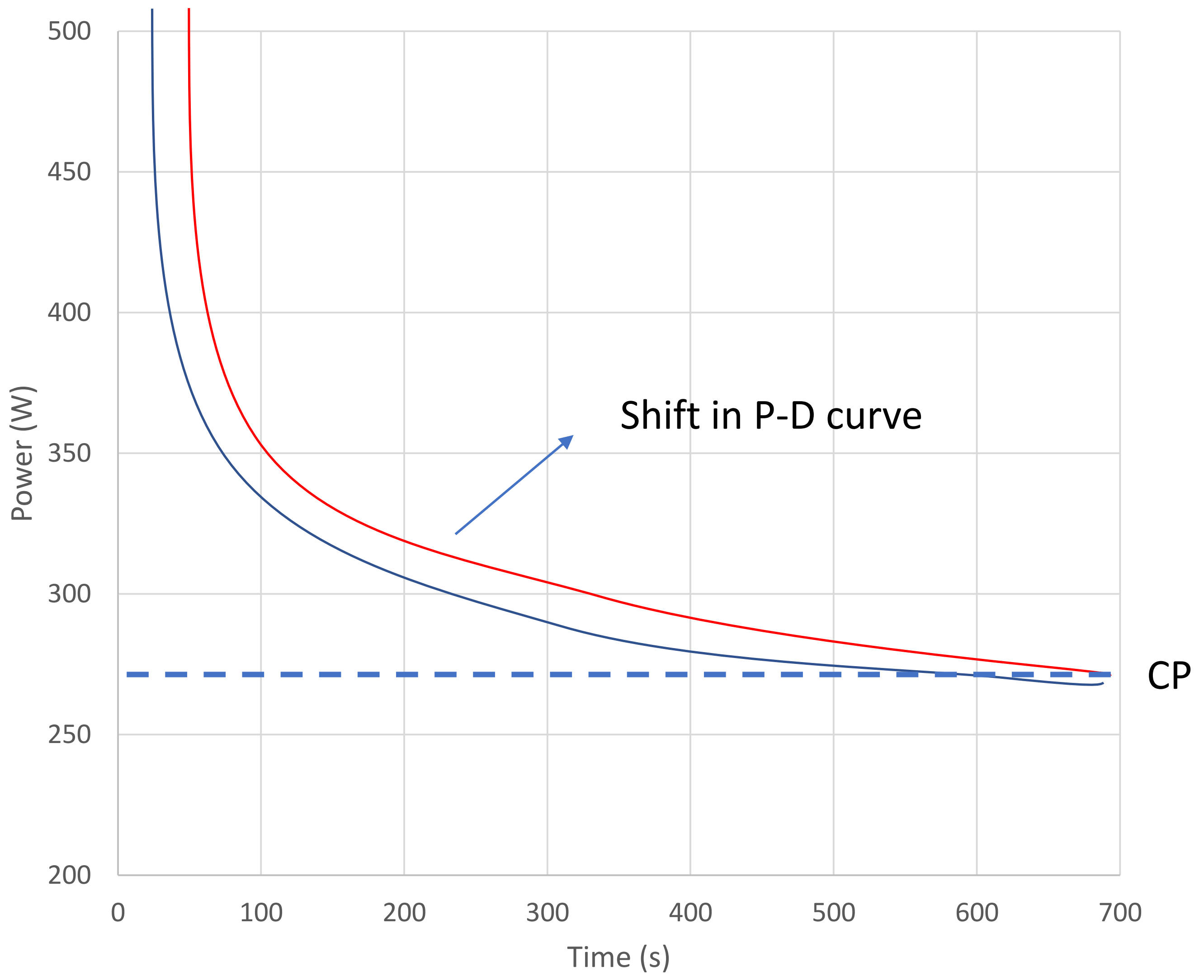
W1 - 60%VO2peak
W2 - 70%VO2peak
W3 - 80%VO2peak
5 min recovery



Bailey et al. 2009

Priming and Power-Duration Relationship

- Burnley et al. (2009) MSSE
- Good calibre cyclists
- No change in CP with priming
- Change in P-D relationship with HVY but not SEV priming



Intermittent HI Priming & 3km TT Cycling Performance

Journal of Sports Sciences, 2014
http://dx.doi.org/10.1080/02640414.2014.960882

Effects of high-intensity intermittent priming on physiology and cycling performance

JORDAN P. R. MCINTYRE & ANDREW E. KILDING

Sports Performance Research Institute New Zealand, AUT University, Auckland, New Zealand

(*Accepted 29 August 2014*)

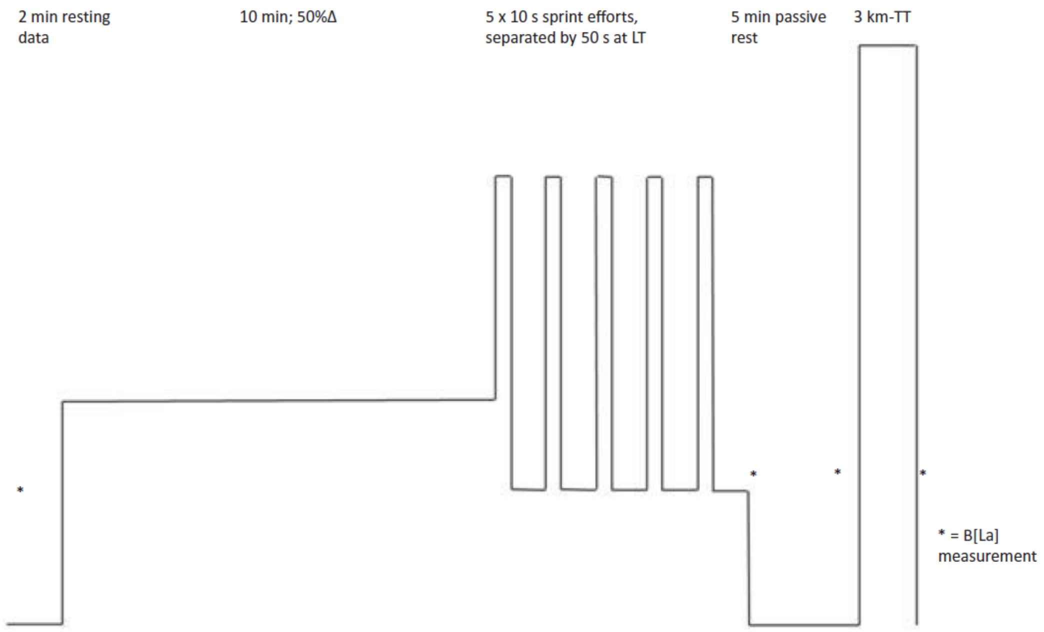


Figure 1. Schematic of the priming exercise protocol.

High-intensity priming, but not too high! McIntyre & Kilding (2014) JSS

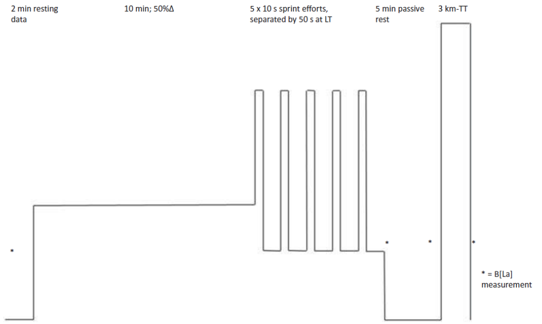
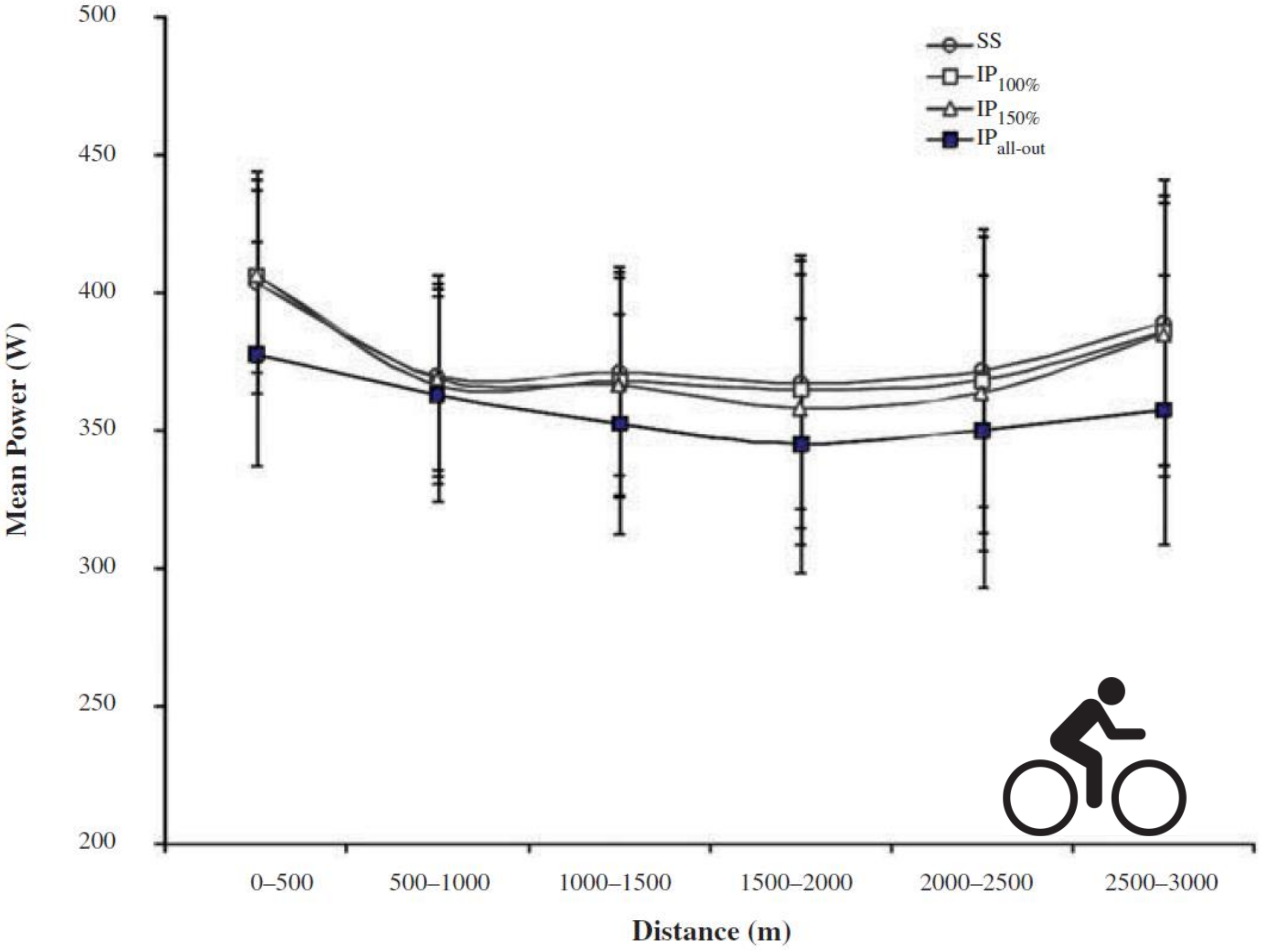


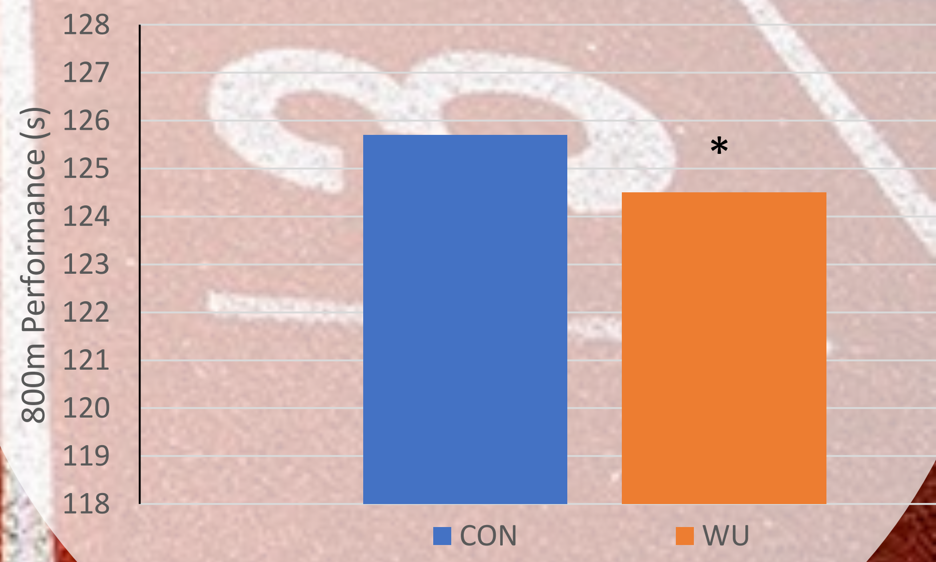
Figure 1. Schematic of the priming exercise protocol.



Ingham et al. (2012) IJSPP - 800m runners

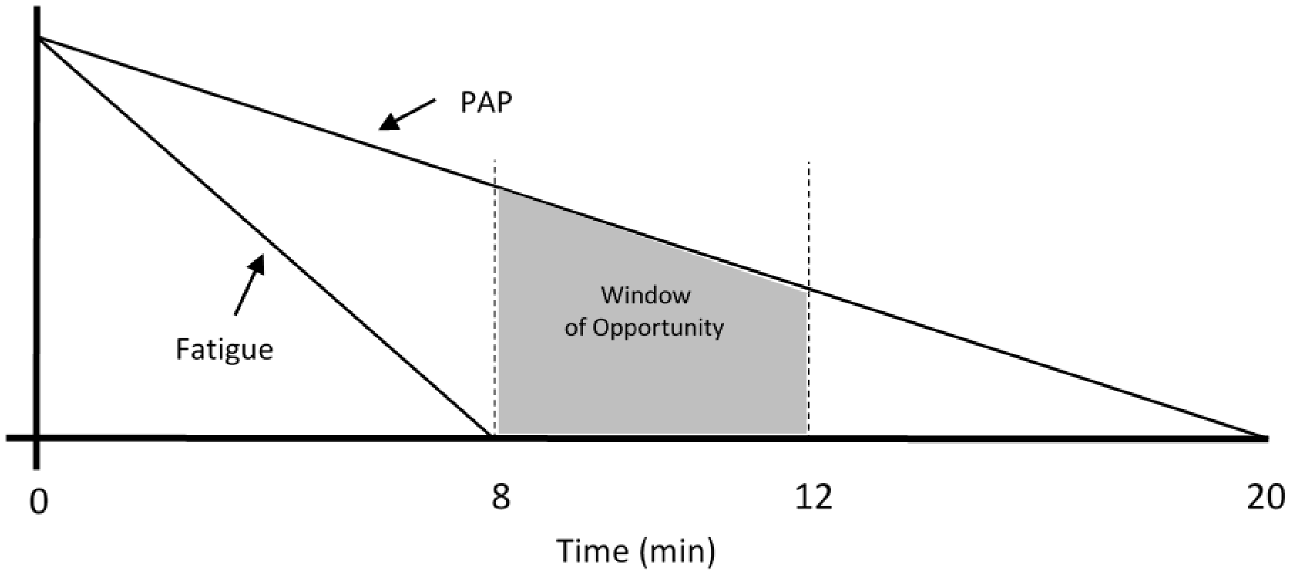
- Modified ‘normal’ warm up to include a HI 200m race pace effort.
- 20 min rest to simulate call up
- Performance gains mostly in 400-500m and 700-800m.

7 out of 11 participants having a faster time (1.2s) for HI WU



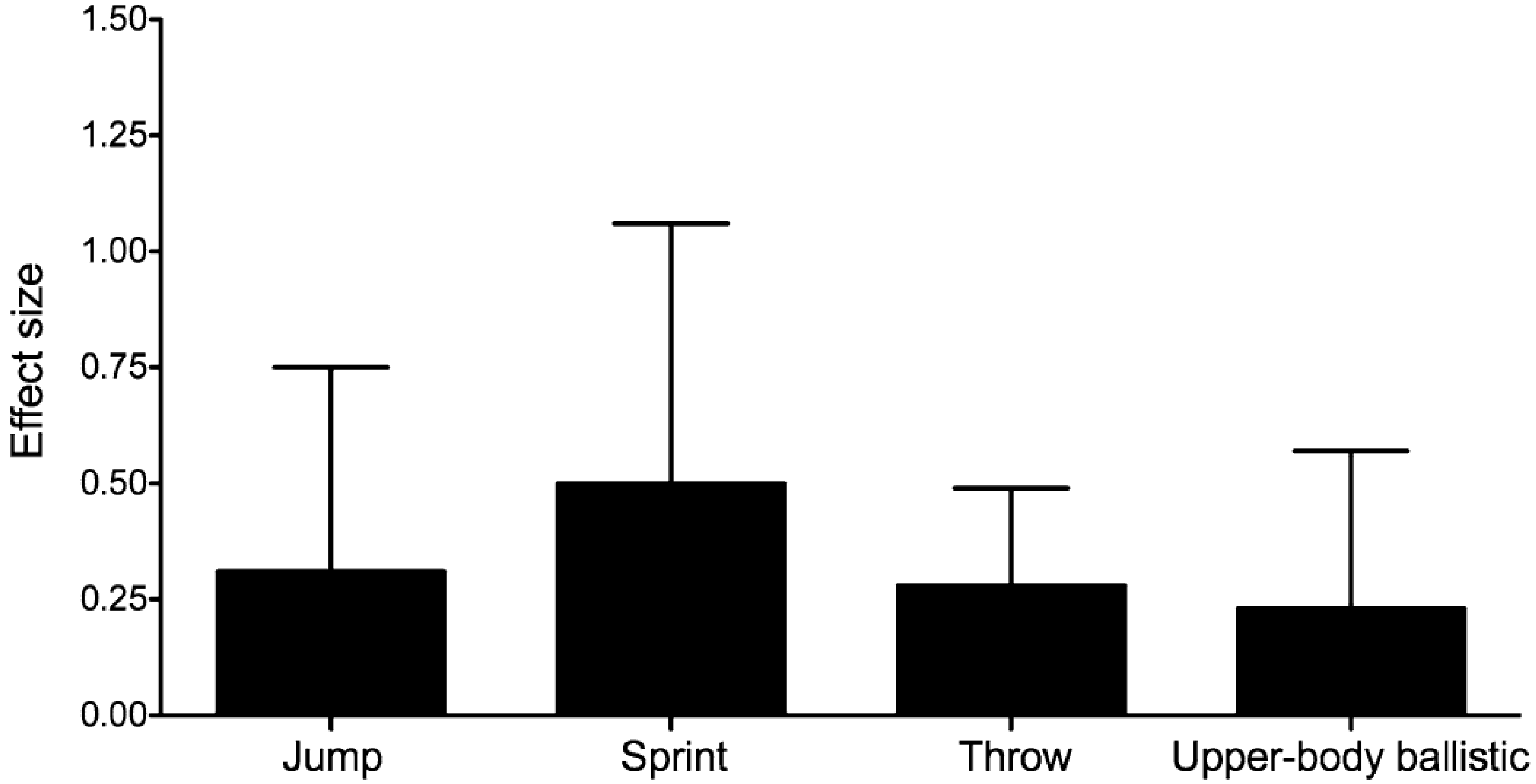
Post-Activation Potentiation (PAP)

- PAP refers to the phenomenon by which acute muscle force output is enhanced as a result of contractile history (Robbins, 2005)
- Traditionally focused on power exercises, because PAP after maximum efforts could be utilized as an intervention that lasts several minutes after an acute conditioning stimulus, thus increasing muscle power output

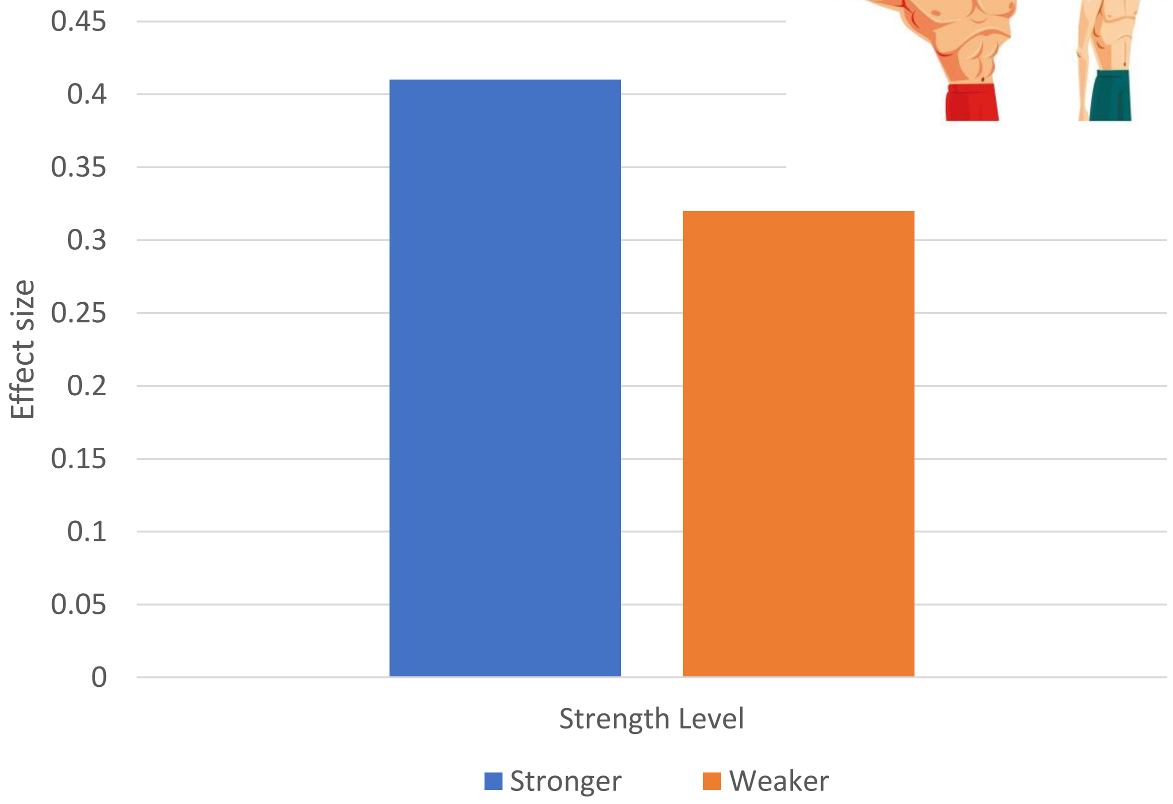


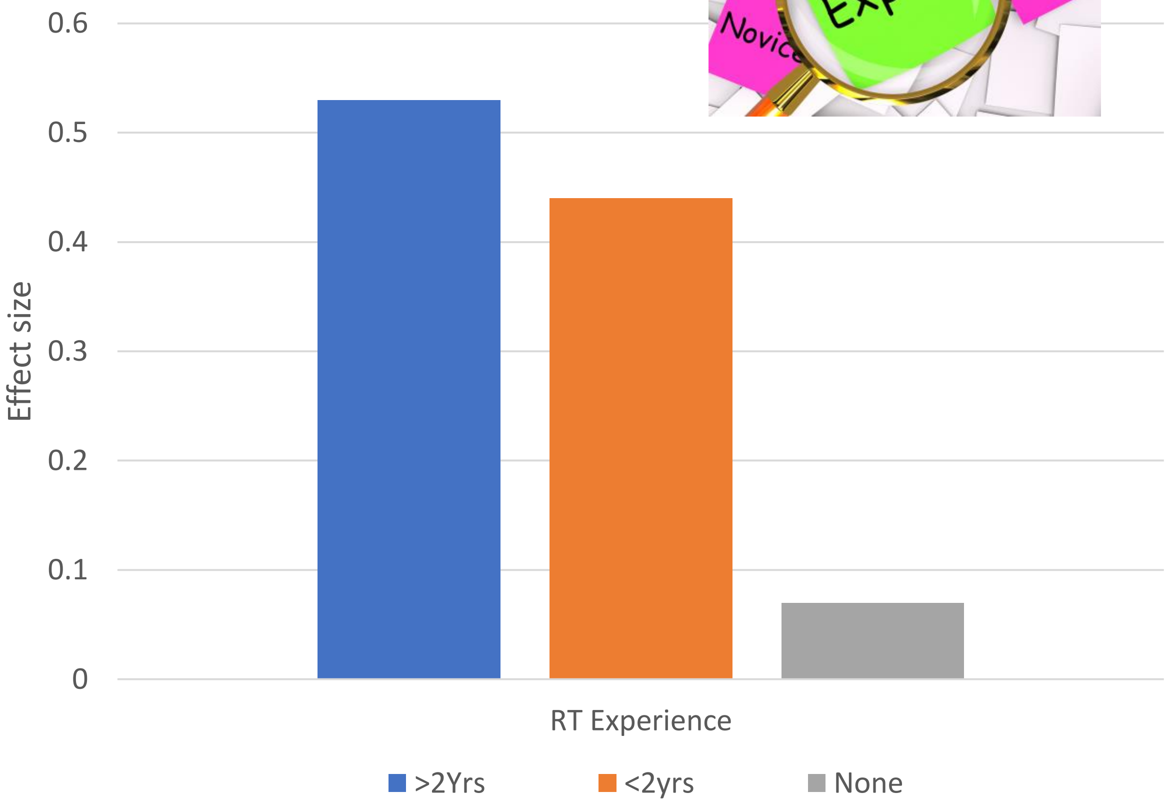
MacIntosh, Robillard, & Tomaras, 2012

PAP for Power/Speed Effects - Seitz & Haff (2016)



Athlete characteristics influencing PAP effects Seitz & Haff, 2016





Effects of PAP loading characteristics Seitz & Haff, 2016

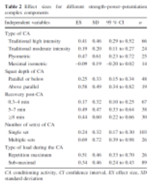
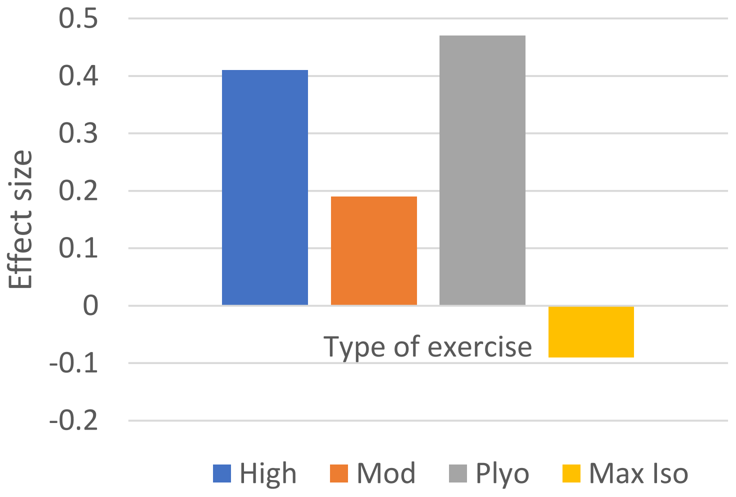
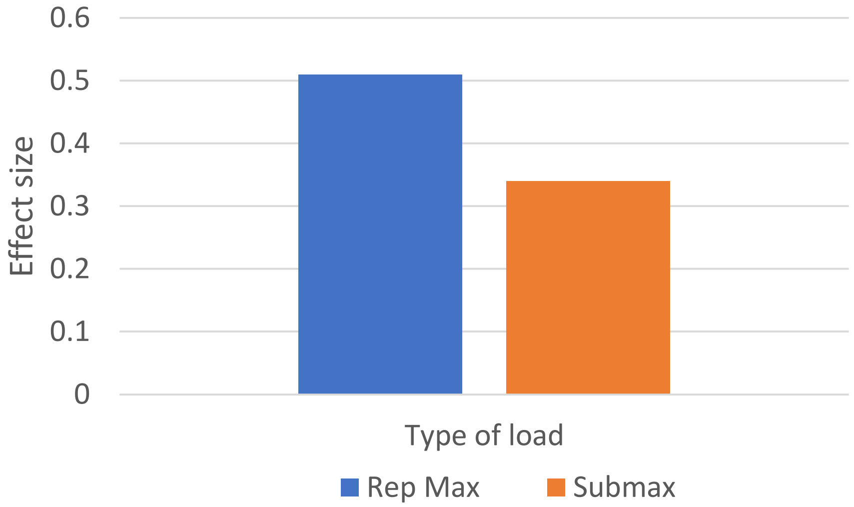


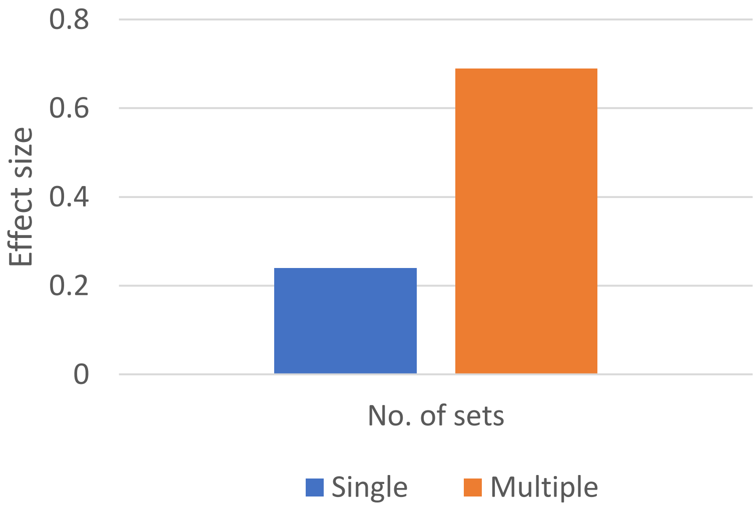
Table 2 Effect sizes for different strength-power-potentiation complex components

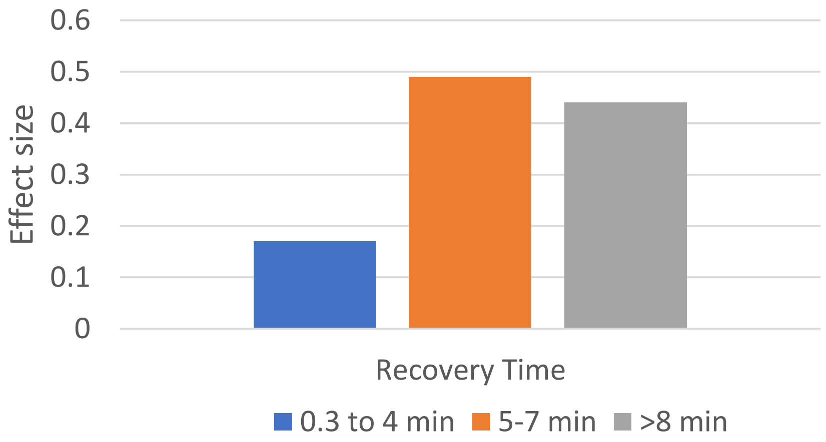
Independent variables	ES	SD	95 % CI	n
Type of CA				
Traditional high intensity	0.41	0.46	0.29 to 0.52	66
Traditional moderate intensity	0.19	0.20	0.11 to 0.27	24
Plyometric	0.47	0.61	0.23 to 0.72	25
Maximal isometric	−0.09	0.19	−0.20 to 0.02	14
Squat depth of CA				
Parallel or below	0.25	0.33	0.15 to 0.34	48
Above parallel	0.58	0.49	0.34 to 0.82	19
Recovery post-CA				
0.3–4 min	0.17	0.32	0.10 to 0.25	67
5–7 min	0.49	0.47	0.33 to 0.64	38
≥8 min	0.44	0.60	0.22 to 0.66	30
Number of set(s) of CA				
Single set	0.24	0.32	0.17 to 0.30	103
Multiple sets	0.69	0.72	0.39 to 0.98	26
Type of load during the CA				
Repetition maximum	0.51	0.46	0.33 to 0.70	26
Submaximal	0.34	0.46	0.24 to 0.43	89

CA conditioning activity, *CI* confidence interval, *ES* effect size, *SD* standard deviation



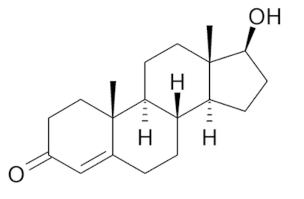




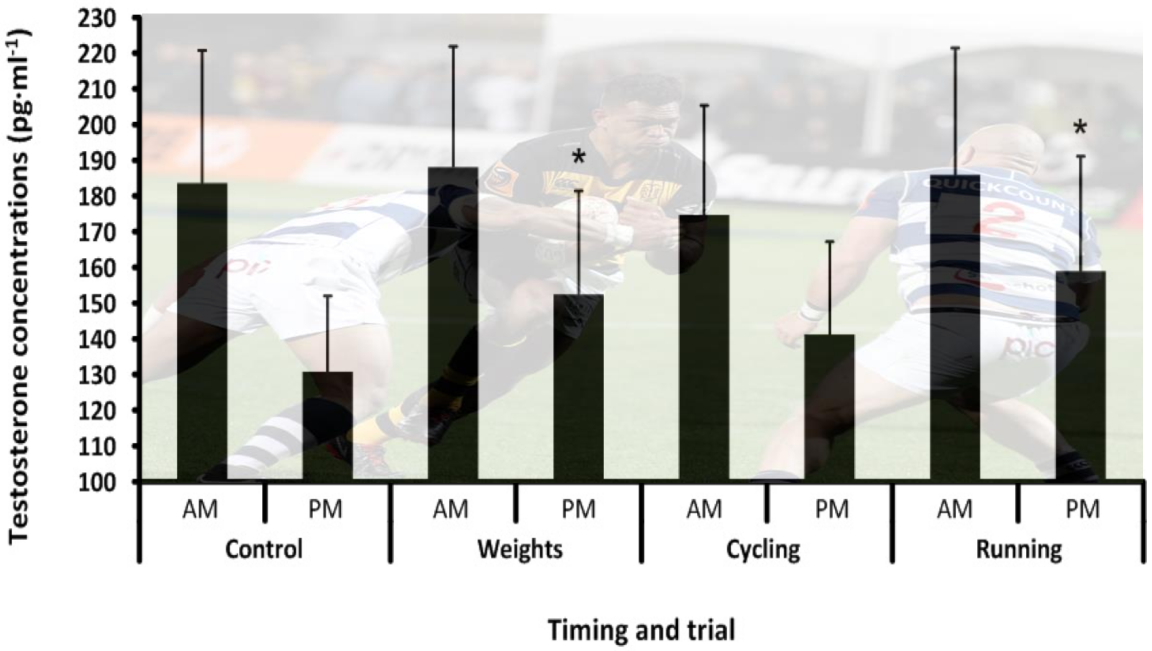


AM Priming for PM Performance

Testosterone



- Some types of AM priming influences PM testosterone, but not cortisol, in PM



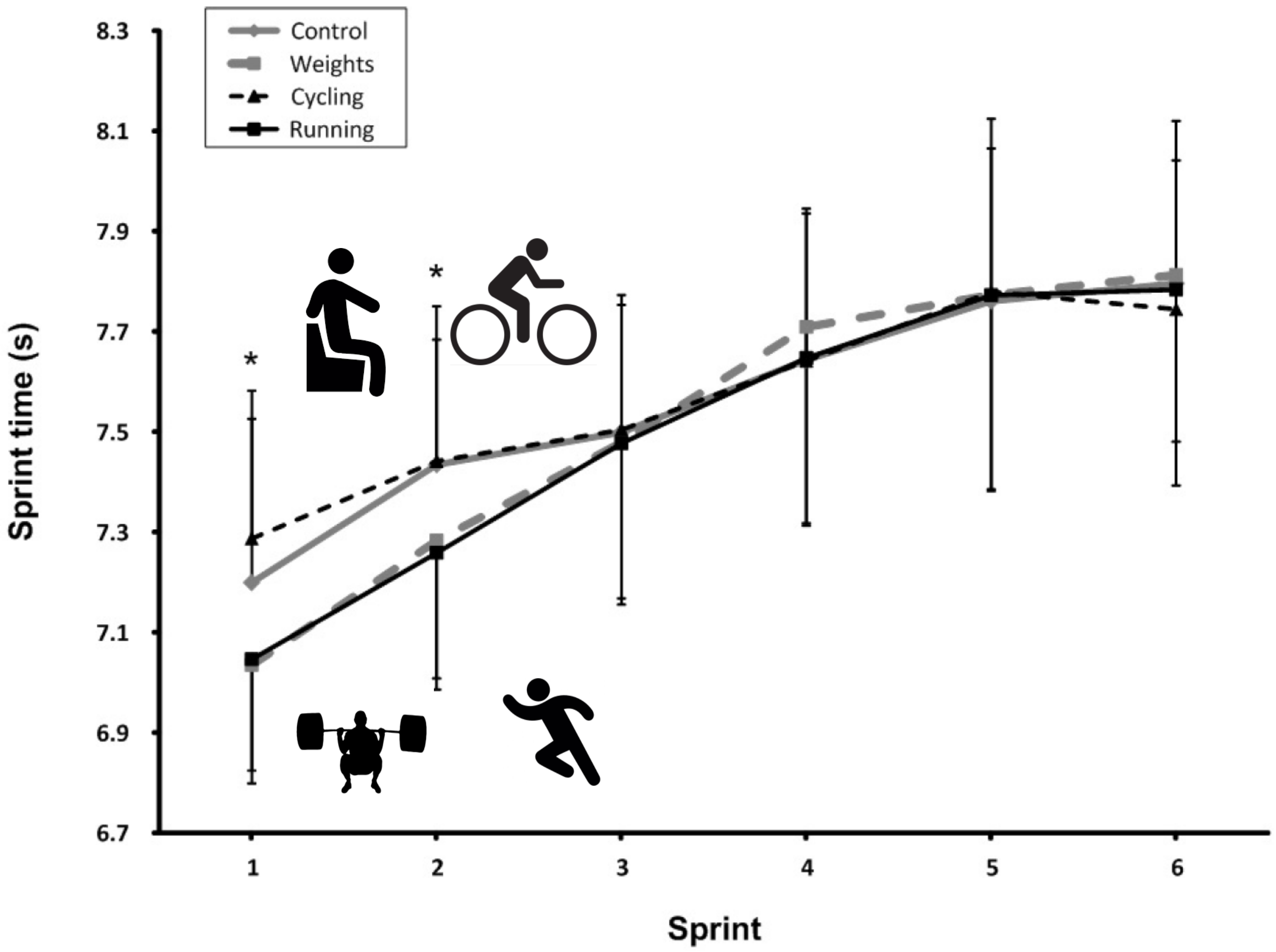
McDonald et al. (2018)
Unpublished

“Mitigated circadian rhythm of testosterone”

Increased T in female athlete

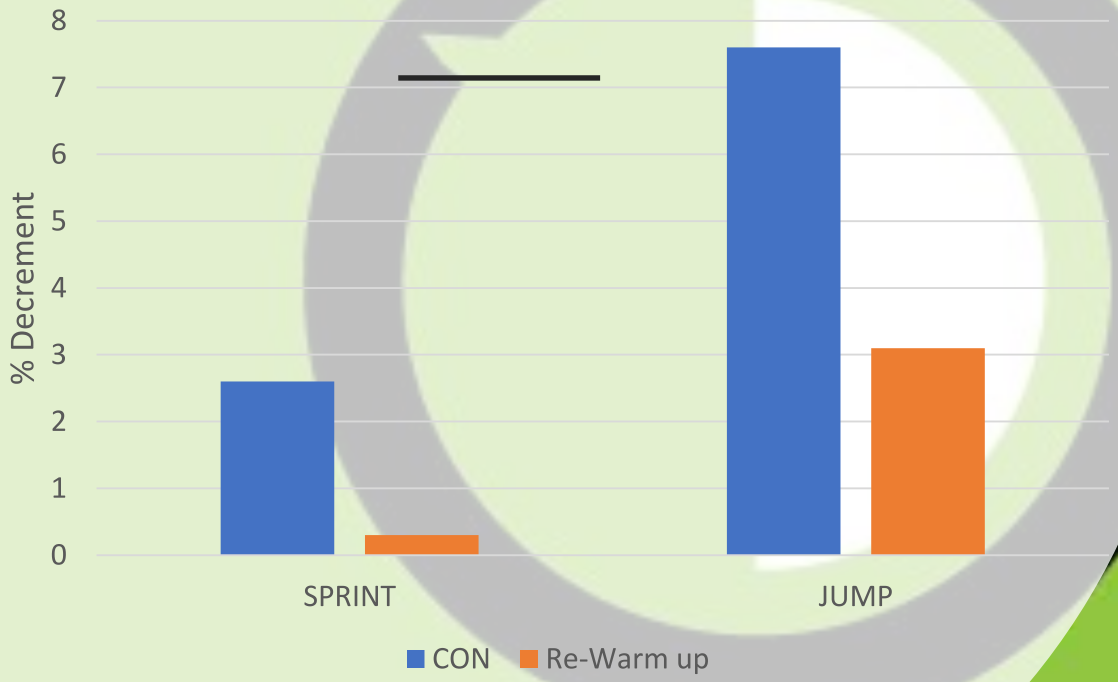
Russell et al. (2016) IJSPP

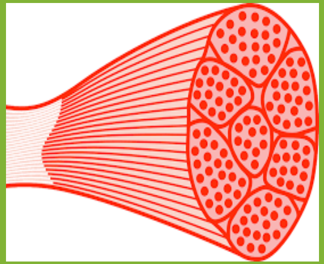
Sprint Performance: AM>>PM Priming



Russell et al. (2016) IJSPP

The half-time “re-warm up”





Eholm et al. 2014, Scand JSM; Mohr et al. 2004, JSS; Silva et al (2018)

PAP for Endurance?

- PAP in Type I AND II fibres
- Hard to identify impact of PAP given several changes occurring during exercise

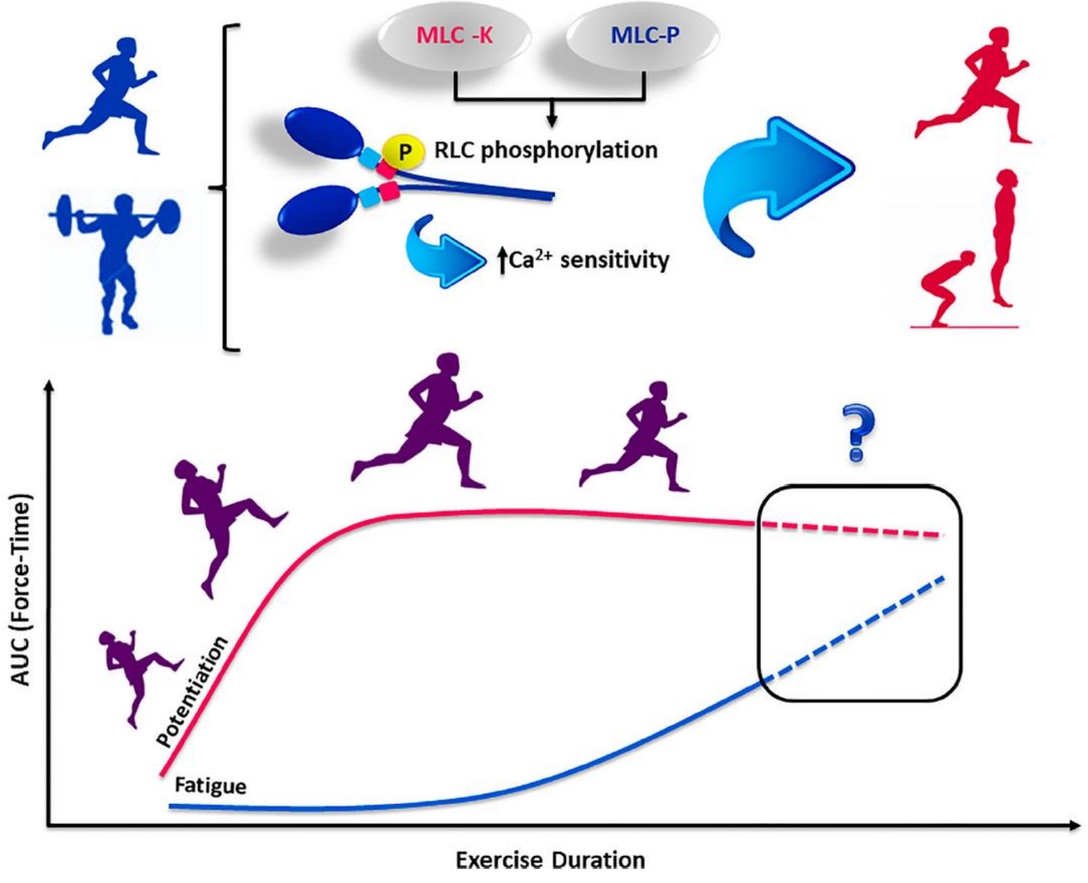


Figure 1. Hypothetical model of post-activation potentiation for endurance sports. RLC, regulatory myosin light chain, MLC-K, myosin light chain kinase; MLC-P = myosin light chain phosphatase; AUC = area under the curve.

Boullosa et al. (2018) EJSS

PAP - Running Economy, Stiffness & Performance

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

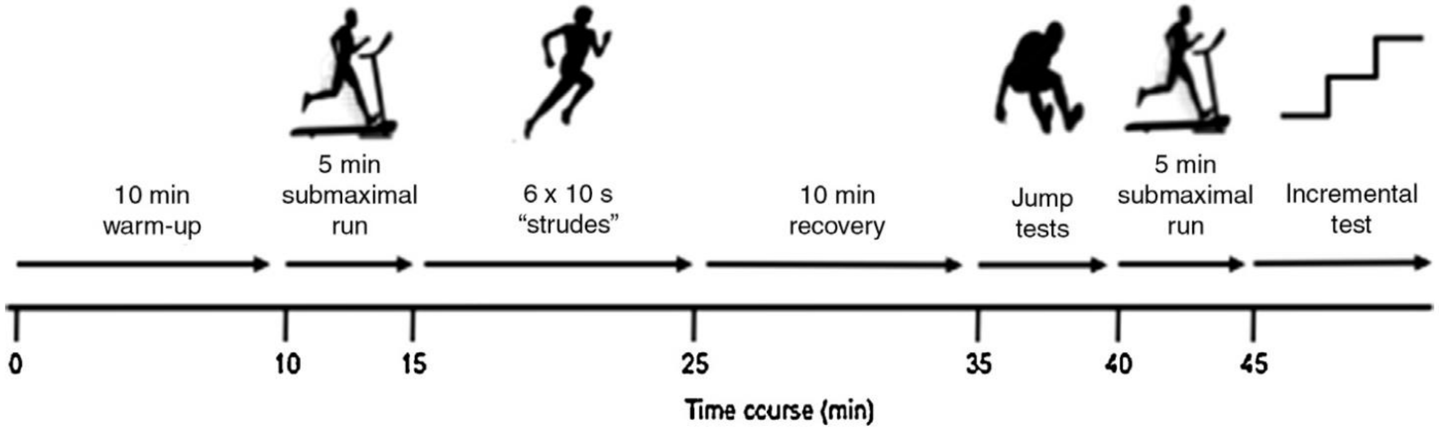
journal homepage: www.elsevier.com/locate/jsams

Original research

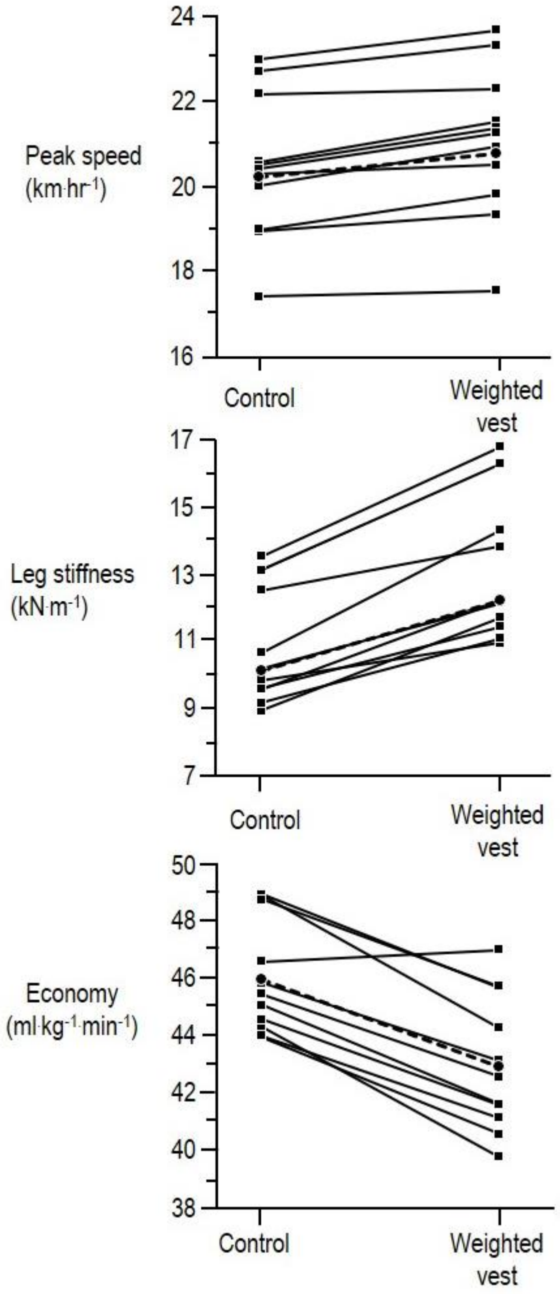
Warm-up with a weighted vest improves running performance via leg stiffness and running economy

K.R. Barnes*, W.G. Hopkins, M.R. McGuigan, A.E. Kilding

Sports Performance Research Institute New Zealand, AUT University, New Zealand



Barnes et al. (2014) JSAMS

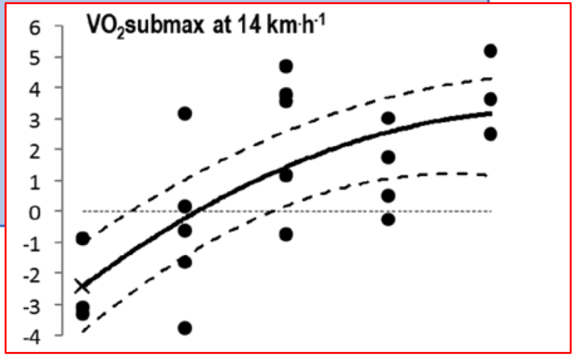


Performance: 2.9; ±0.8%; very large benefit**

Stiffness: 20 ; ±4.2%; moderate +ve

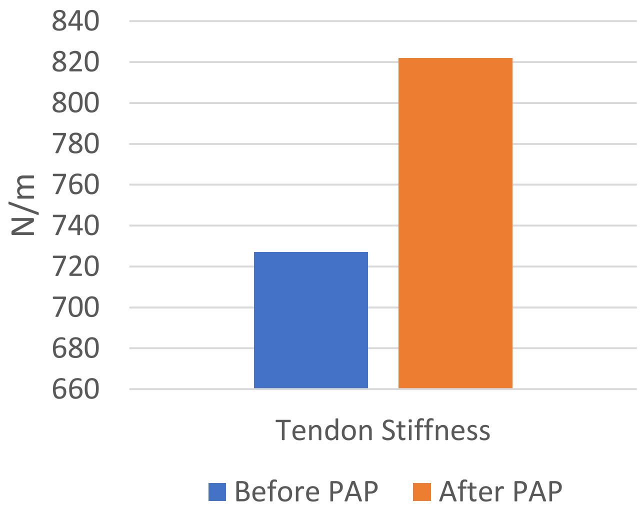
Economy: -6.0 ; ±1.6%; large +ve

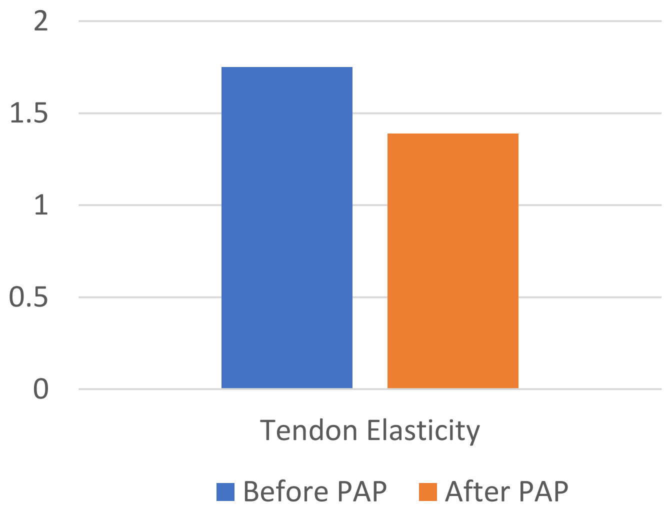
Is there an optimal vest weight? Dose response

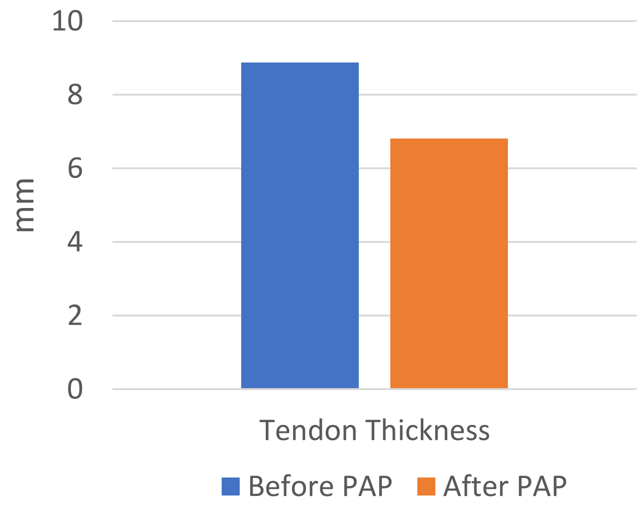


PAP Changes Tendon Characteristics

corresponding to 60%, 70%, 80%, 90% and 100% of 1 RM until their 1 RM was reached







Wearable resistance technology

- Small to large mass loading
- Targeted positioning
- Uni or multi segment loading

SPORTS BIOMECHANICS
https://doi.org/10.1080/14763141.2018.1508490

Routledge
Taylor & Francis Group

ARTICLE

Check for updates

Effects of upper and lower body wearable resistance on spatio-temporal and kinetic parameters during running

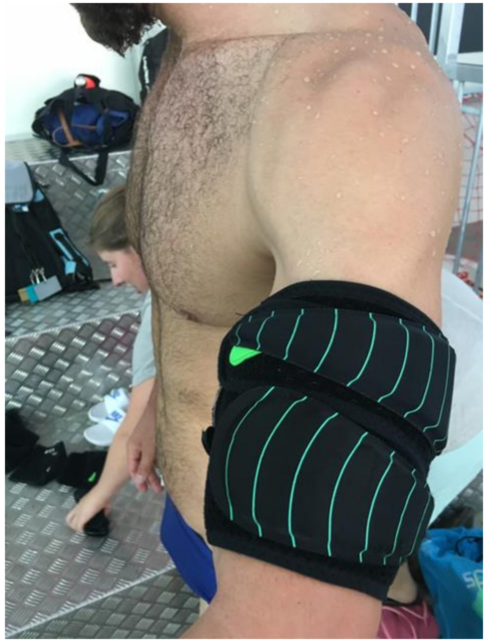
Grace A. Couture[a,b], Kim D. Simperingham[a], John B. Cronin[a,c], Anna V. Lorimer[a], Andrew E. Kilding[a] and Paul Macadam[a]

[a]Sports Performance Research Institute New Zealand, Auckland University of Technology, Auckland, New Zealand; [b]Department of Movement Science, Grand Valley State University, Allendale, MI, USA; [c]School of Exercise and Biomedical Health Science, Edith Cowan University, Perth, Australia

PAP Swimming

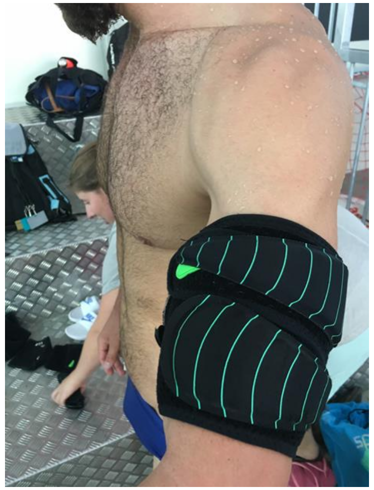
Table 2. **Example of how load was prescribed and reflected participant characteristics**

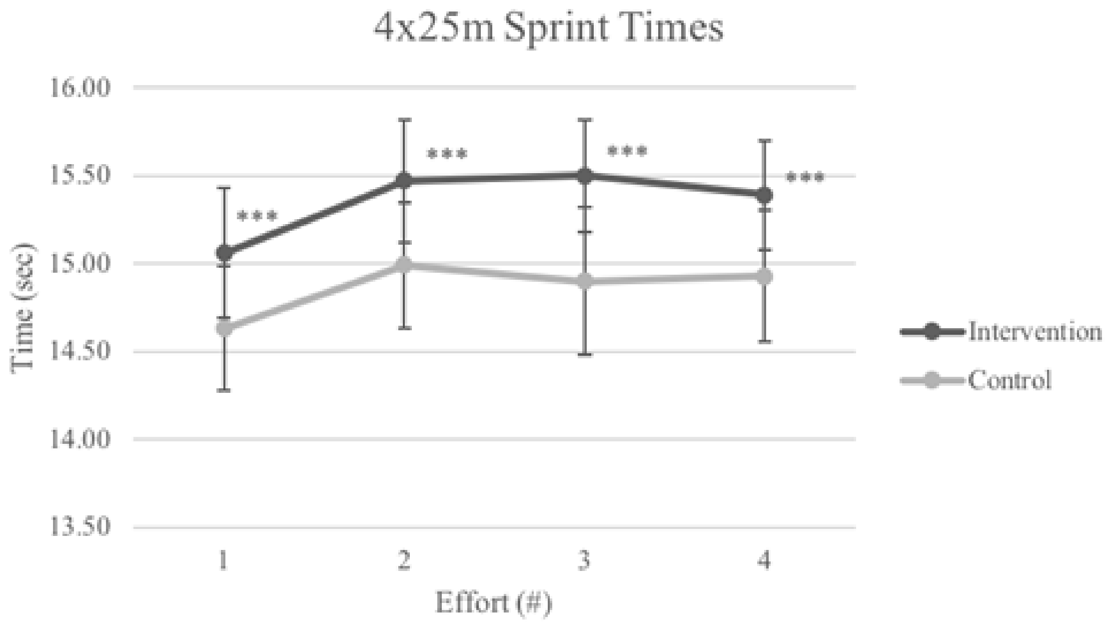
Subject	Gender	Age	Experience	Variables	Values
1025	Female	16	Age Group National Finalist	LBW	51.10 kg
				PB Time	138.74 sec
				Ratio	0.331
				Load per arm	**300g**
1015	Female	24	International	LBW	61.50 kg
				PB Time	120.09 sec
				Ratio	0.461
				Load per arm	**400g**
1011	Female	16	Age Group Nationals	LBW	37.25 kg
				PB Time	143.45 sec
				Ratio	0.231
				Load per arm	**200g**

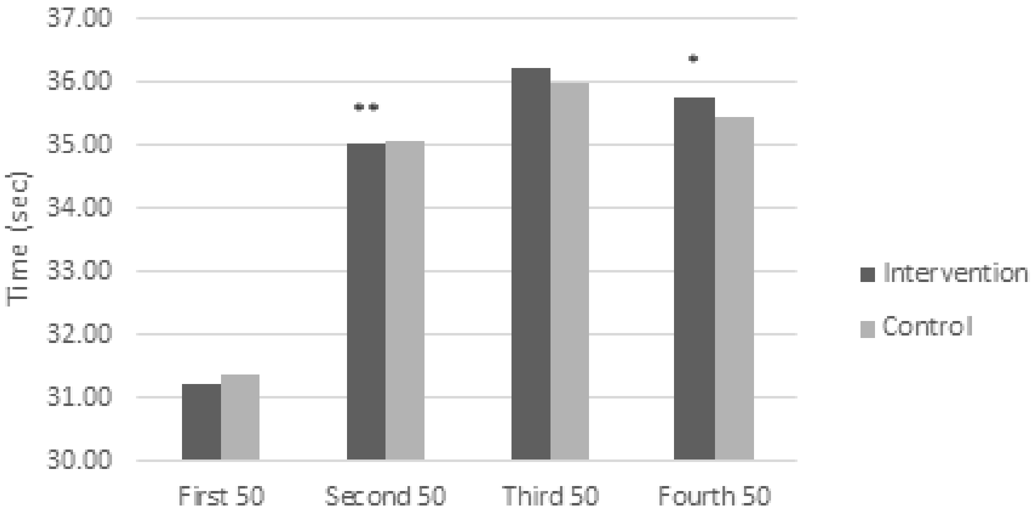


Quirke, Plews, Kilding, *Unpublished*

PAP Swimming

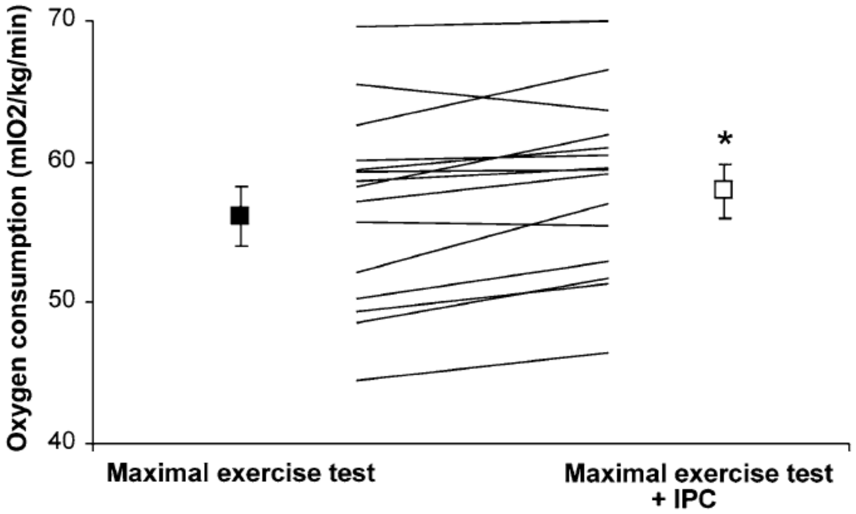






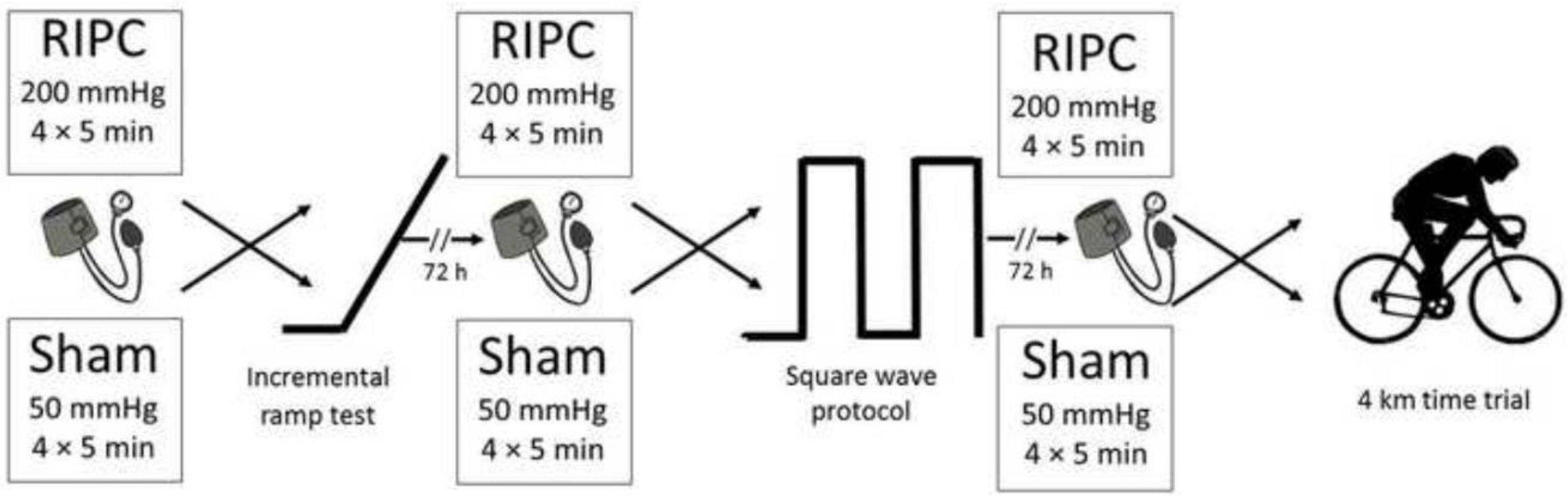
Quirke, Plews, Kilding, *Unpublished*

Ischemic Preconditioning (IPC)



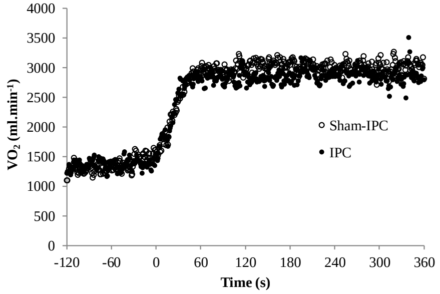
de Groot et al. (2009) EJAP

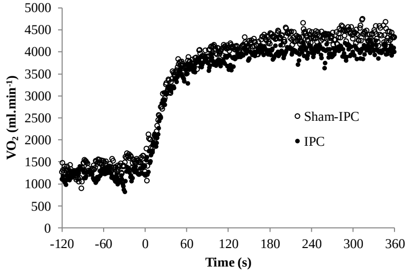
IPC and Cycling Performance Kilding et al. (*2018)* EJAP

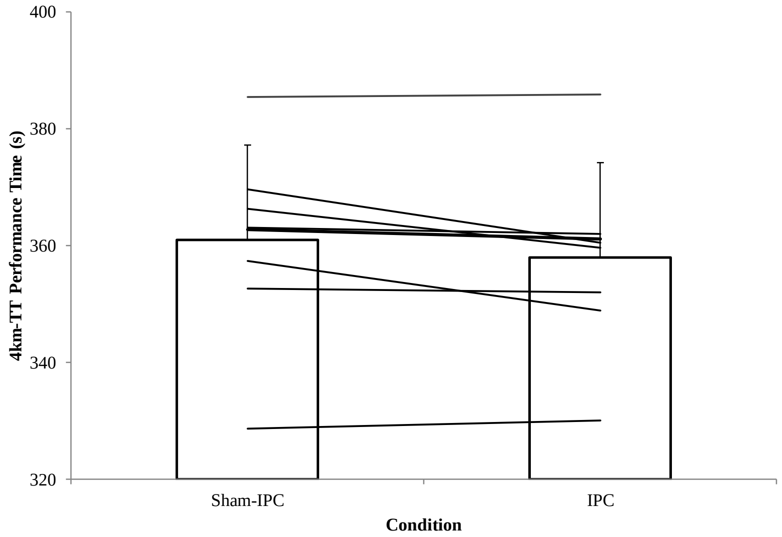


IPC and Cycling Performance

- No change in MOD VO_2 kinetics
- Reduction in VO_2 slow component magnitude
- Tendency for improved efficiency
- Small effect (2.2%; ES 0.18) on 4k TT performance

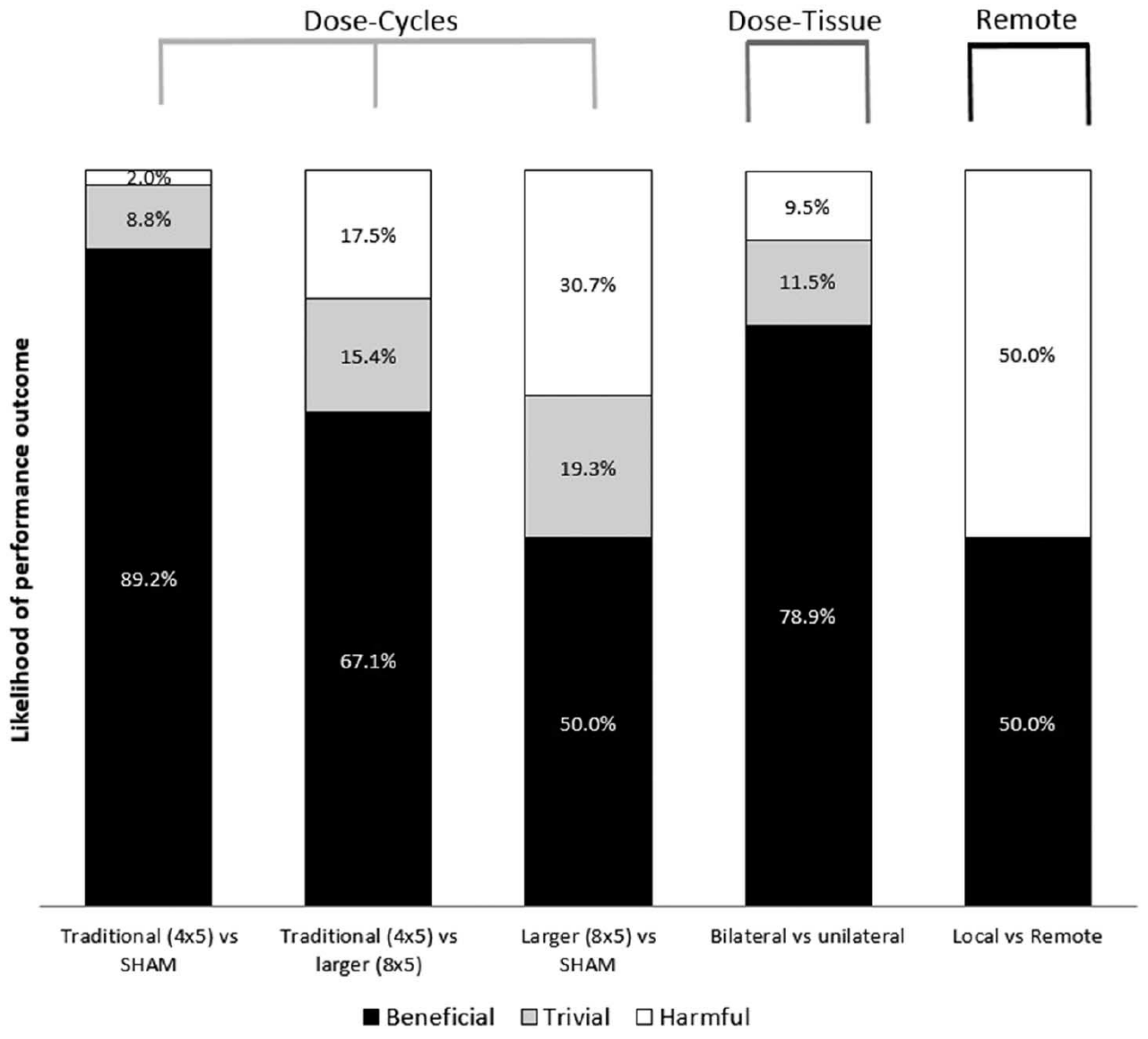






Kilding et al. (*2018*) EJAP

Is There an Optimal Ischemic-Preconditioning Dose to Improve Cycling Performance? Cocking et al. (2018) IJSPP



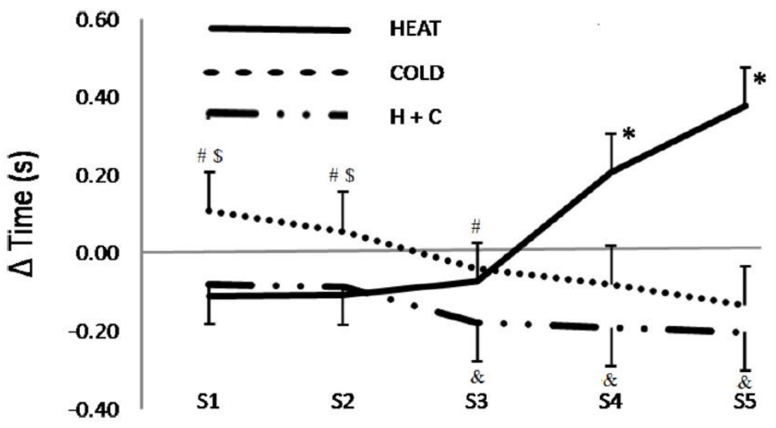
Passive Heating

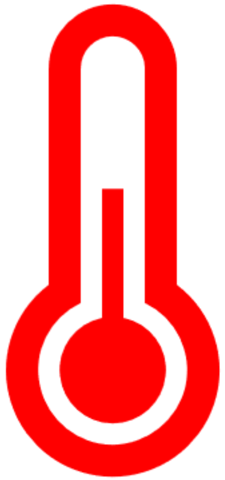
Don't Get Too Hot?

Combining Passive Strategies

Beaven et al. (2018) Frontiers Physiol

- Passive heat (H) vs Ice slurry (C) vs H+C, used prior to RSA test in temperate conditions.
- Sprint 1 improved in H and H+C
- H worse during sprints 4 & 5
- Higher core temp and HR in HEAT





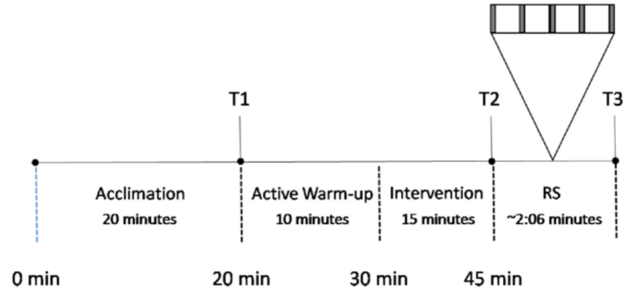
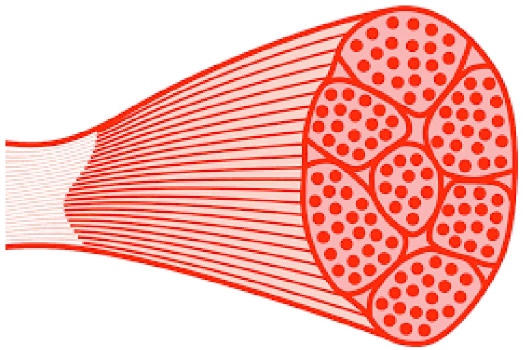


FIGURE 1 | Experimental protocol. RS, repeated sprint exercise (5 × 40 m running sprint); T1, prior to warm-up; T2, prior to the RS; T3, post RS.



Inspiratory Warm-Up for Sport Performance

IM Warm-up: 2 x 30 @ 40%MIP

Tong & Fu (2006)
Improved TTE ~19%
Reduced breathlessness

Ohya et al. (2015)
10 × 5 s with 25-s recovery
No Effect on power/performance

Lin et al. (2007)
Footwork test was incr. 6.8%
Reduced breathlessness

What could an event day priming strategy look like?

*Of course, very sport & athlete specific…..

Half time re--prime

AM PAP

PM PAP or Priming (specific) Music Insp W-up

6hr

2hr

10 min

4hr

1hr

Passive heating (if cool/temperate)

General W-up routine
Coach interaction, Music?

Bobsleigh Example Cook et al. (2013) IJSPP

International Journal of Sports Physiology and Performance, 2013, 8, 213-215

INTERNATIONAL JOURNAL OF
SPORTS PHYSIOLOGY
AND PERFORMANCE
www.IJSPP-Journal.com
CASE STUDY

Designing a Warm-Up Protocol for Elite Bob-Skeleton Athletes

Christian Cook, Danny Holdcroft, Scott Drawer, and Liam P. Kilduff

Discussion

e results demonstrated that intensity, duration, and body temperature are characteristics of successful warm-up, the latter also being achievable by passive means. The 2 most successful protocols in term of performance were P3 and P5. P3 was associated with the highest intensity and duration of activity closest to performance testing, while P5 used this in a 2 × 10-minute split manner but incorporated the heat-retention garment. Tympanic temperature and heart rate were chosen due to athlete compliance and did show significance in difference.

In this group of elite skeleton athletes, high-intensity warm-up with some activity close to time of performance improved sprint performance, and this performance carried over to subsequent Olympic-cycle best push track times. Shorter durations were favored, and athletes subjectively feel better with these and with warm-ups with some overlap to previous traditions. Indeed, athletes chose to comply to a modified warm-up that did not produce the best performance data (albeit significantly better than their traditional one, and equal to the best when combined with a heat-retention garment). Athlete belief and acceptance were thus crucial to adoption of the warm-up going forward to the Olympic Games. The addition of a heat-retention garment between warm-ups and up to performance testing had a beneficial performance outcome and was easily adoptable. Actual elite athletes' adoption and practicality in the competitive environment are essential factors to consider in studies of warm-ups if they are to be ultimately implemented.

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Take Home Messages

- Consider the sport and athlete specific factors influencing the priming decision(s)
- Decide what from your tool box could be effective, practical and accepted
- Consider trialling a multi-system approach – sport & athlete specific
- PAP – beneficial for speed, power AND endurance (look at mode, duration, and athlete characteristics to optimise) – muscle & tendon
- AM for PM shows promise but more research needed across sports
- Vs Control, HI "metabolic" priming effective across range of intensities >CP. *Self chosen also effective.
- Intensity & recovery duration key for PAP and HI priming effects

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Thanks for your attention!