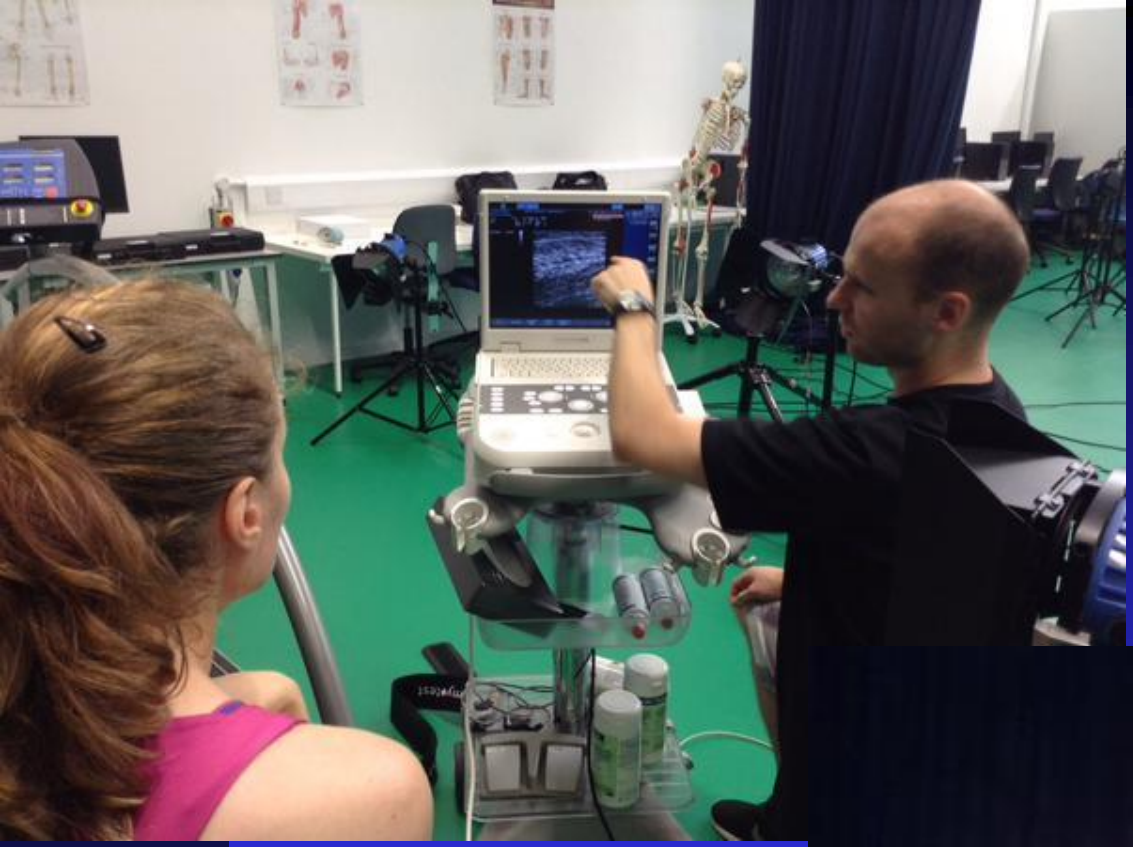
Elasticity in Race Walking

Dr Brian Hanley
b.hanley@leedsbeckett.ac.uk

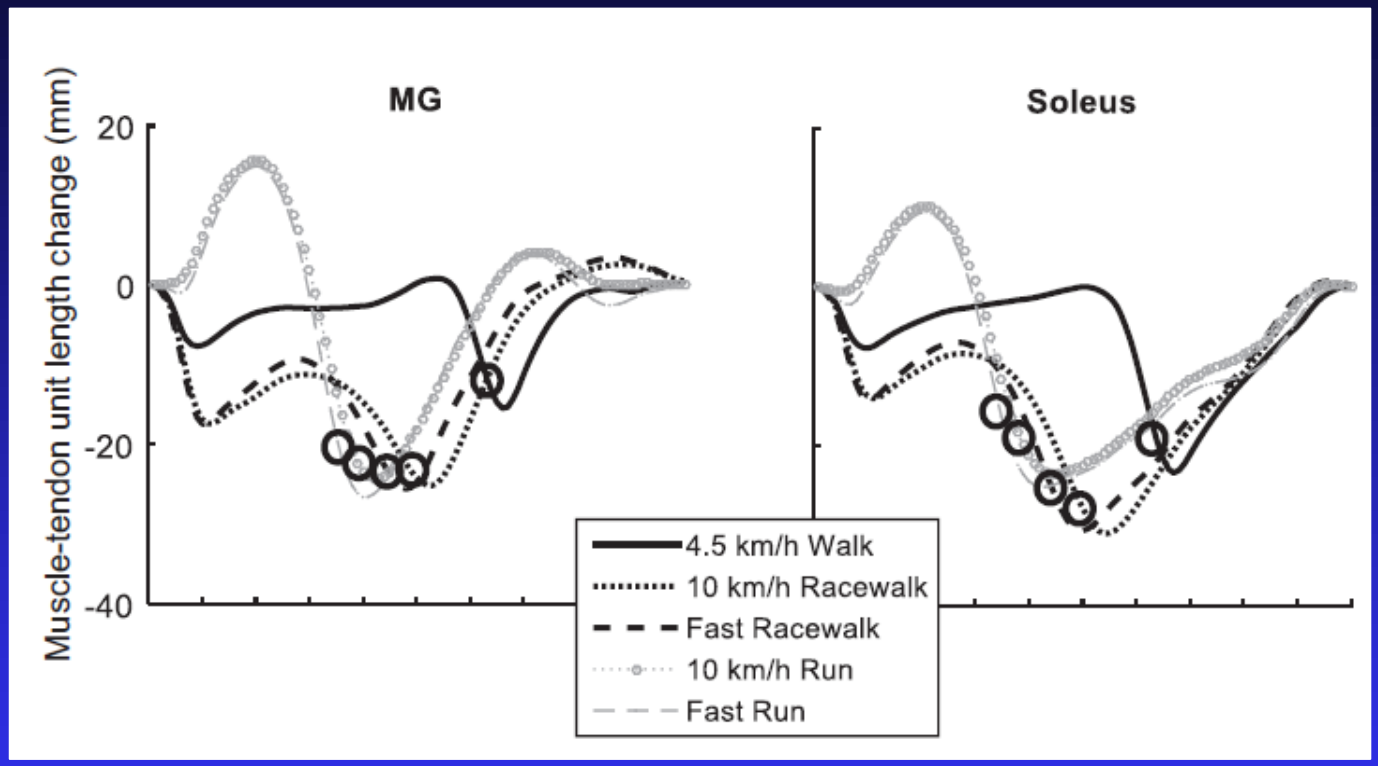
LEEDS BECKETT UNIVERSITY

Introduction

- Modern race walking is a dynamic event where speed and endurance are important determinants of success. The elasticity of the muscular system is an important component of fast and efficient race walking.



Muscle-tendon elasticity



Cronin et al., 2016

- The Achilles tendon and calf muscles are very important in running with regard to energy storage and re-use, but they do not perform this function in race walking because of how the knee is straightened. Elastic energy comes from other sources, however.

Participant details

- >100 athletes have been tested over the past 11 years.
- The athletes ranged in ability from beginners to an Olympic Champion.
- The first tests examined the role of the muscles in the leg, whereas more recently the tests have focused on the arms and upper body.

Muscles chosen

Gluteus maximus

Rectus femoris

Vastus lateralis

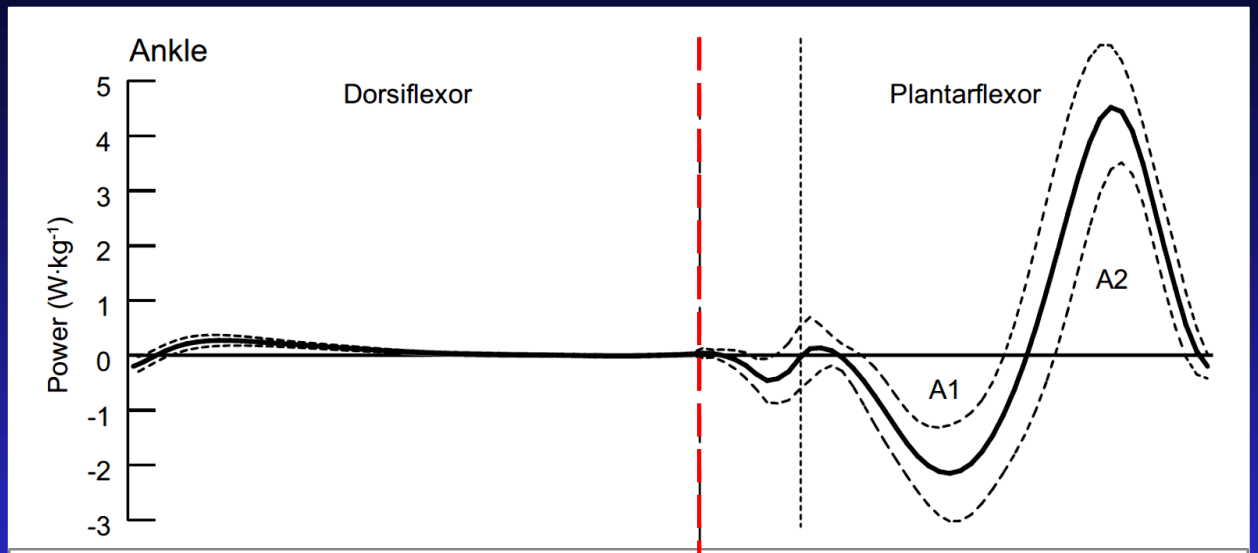
Biceps femoris

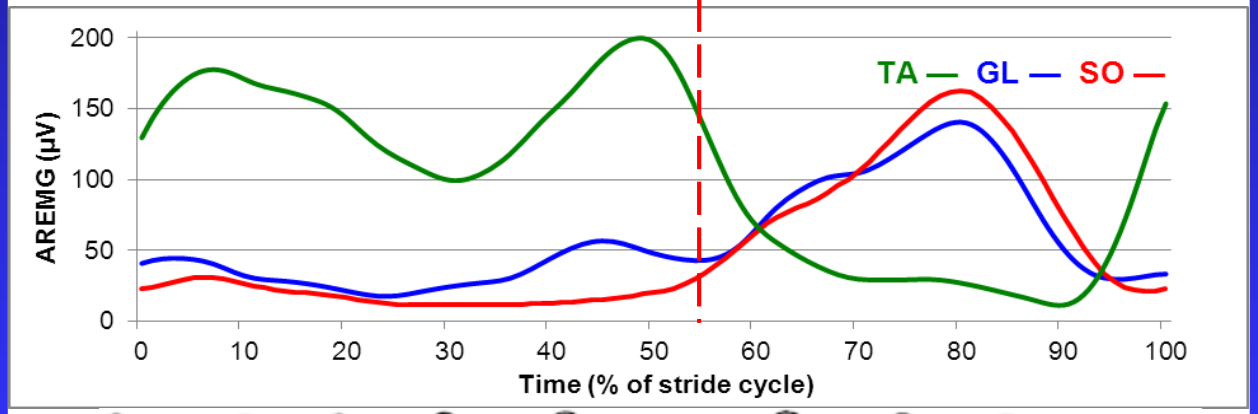
Tibialis anterior

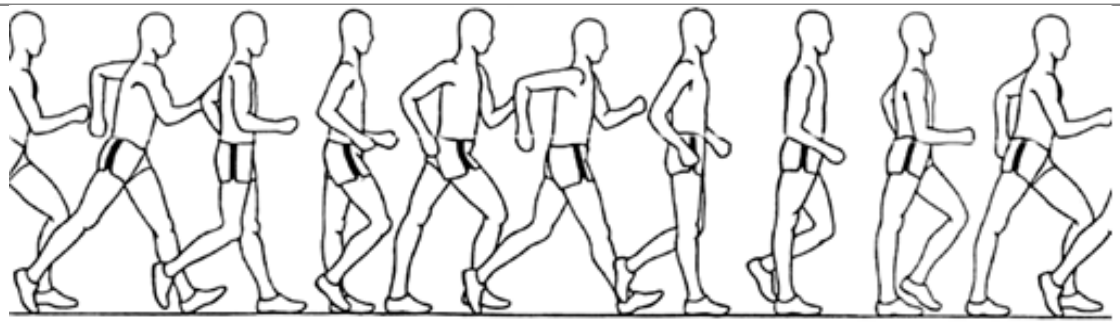
Gastrocnemius

Soleus

Tobillo



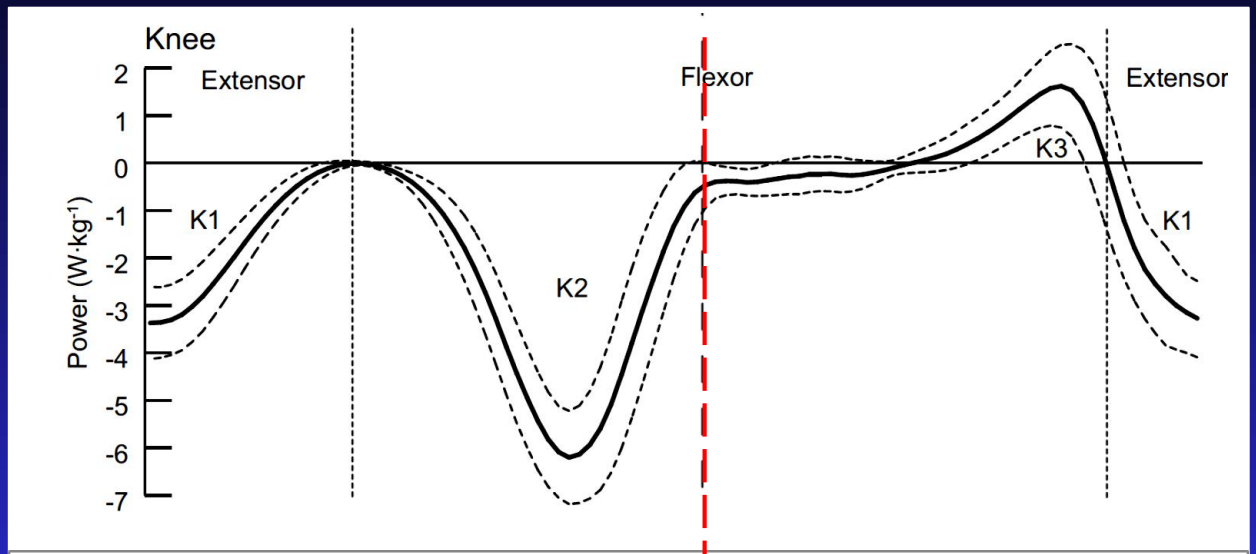


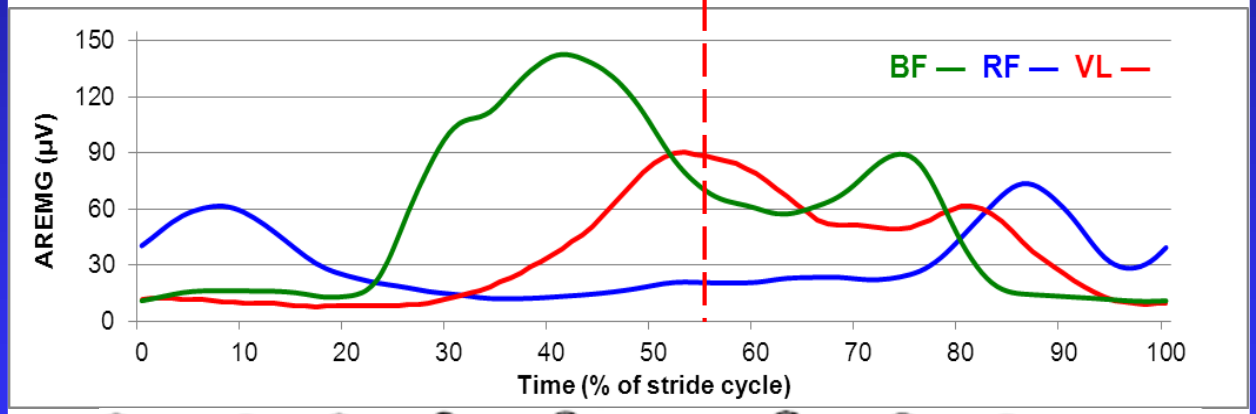


Hanley & Bissas, 2017

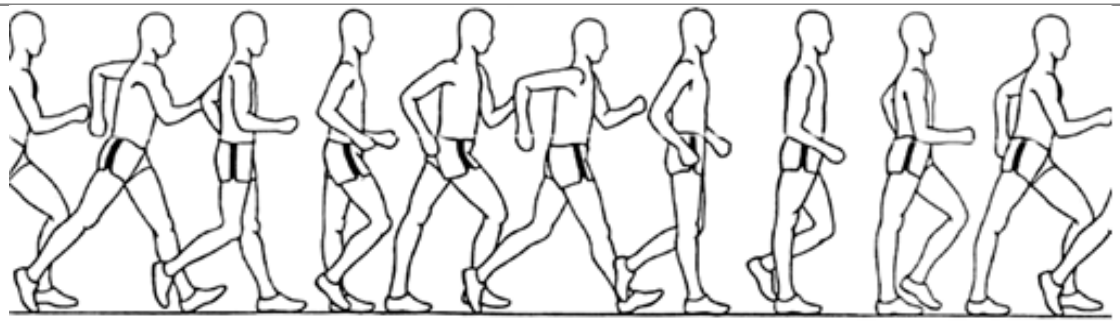
Laird (2000)

Rodilla



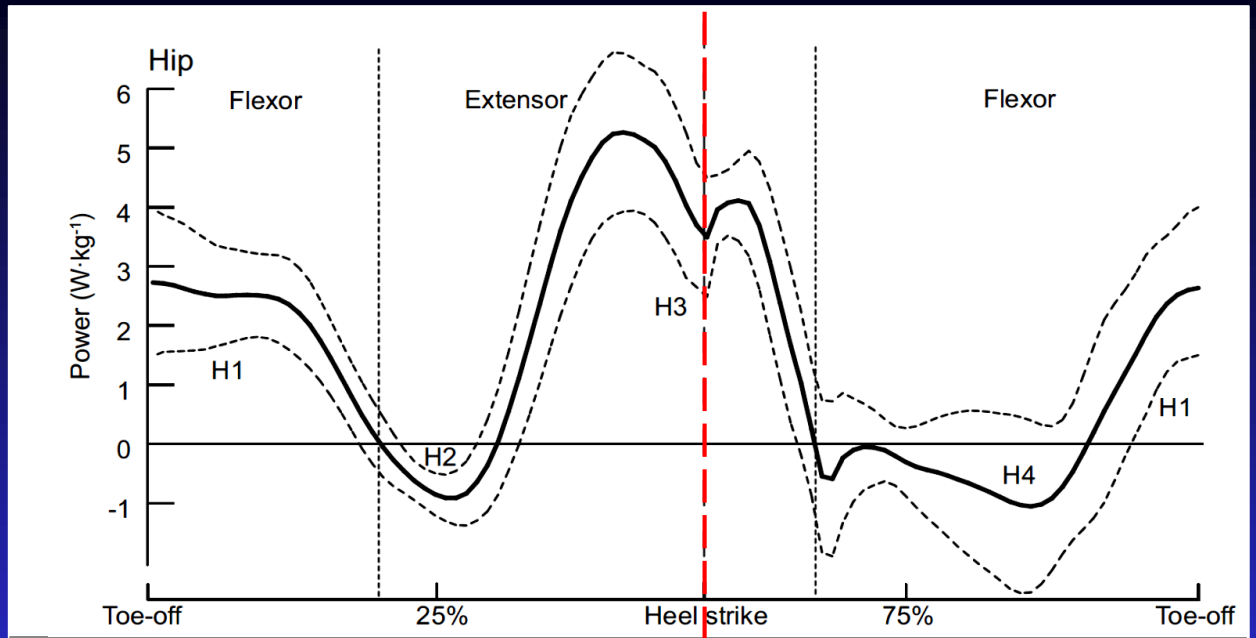


Hanley & Bissas, 2017

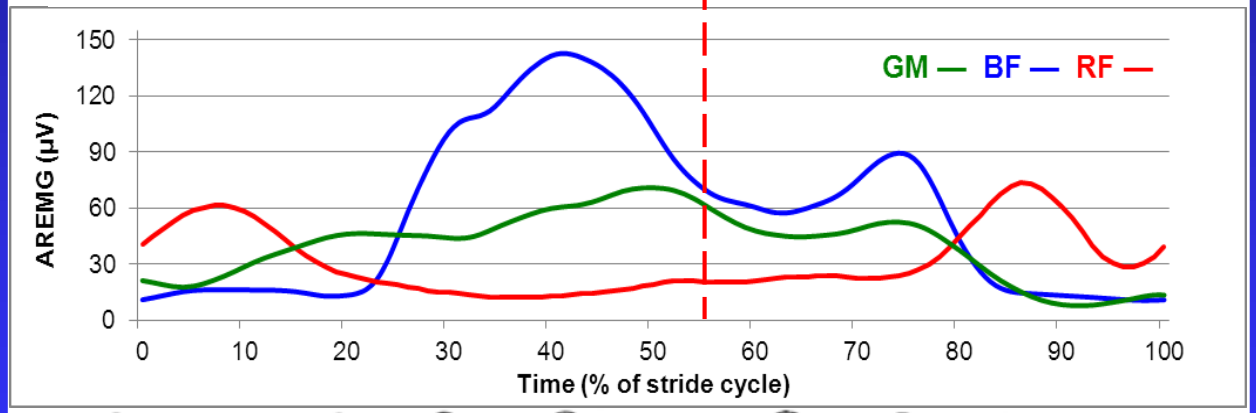


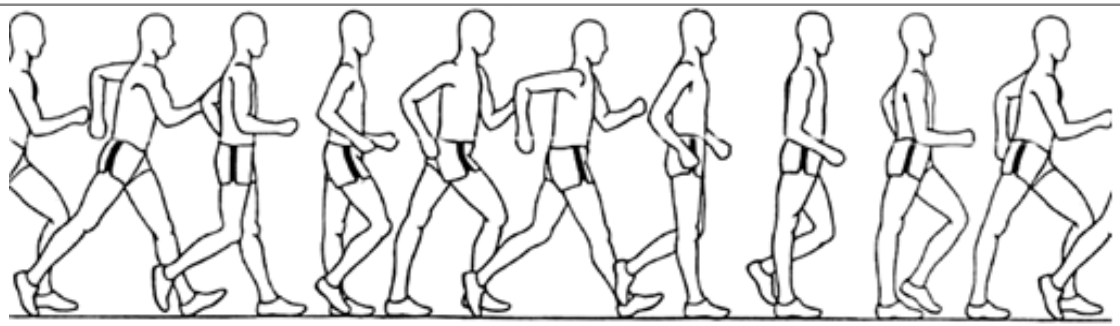
Laird (2000)

Cadera



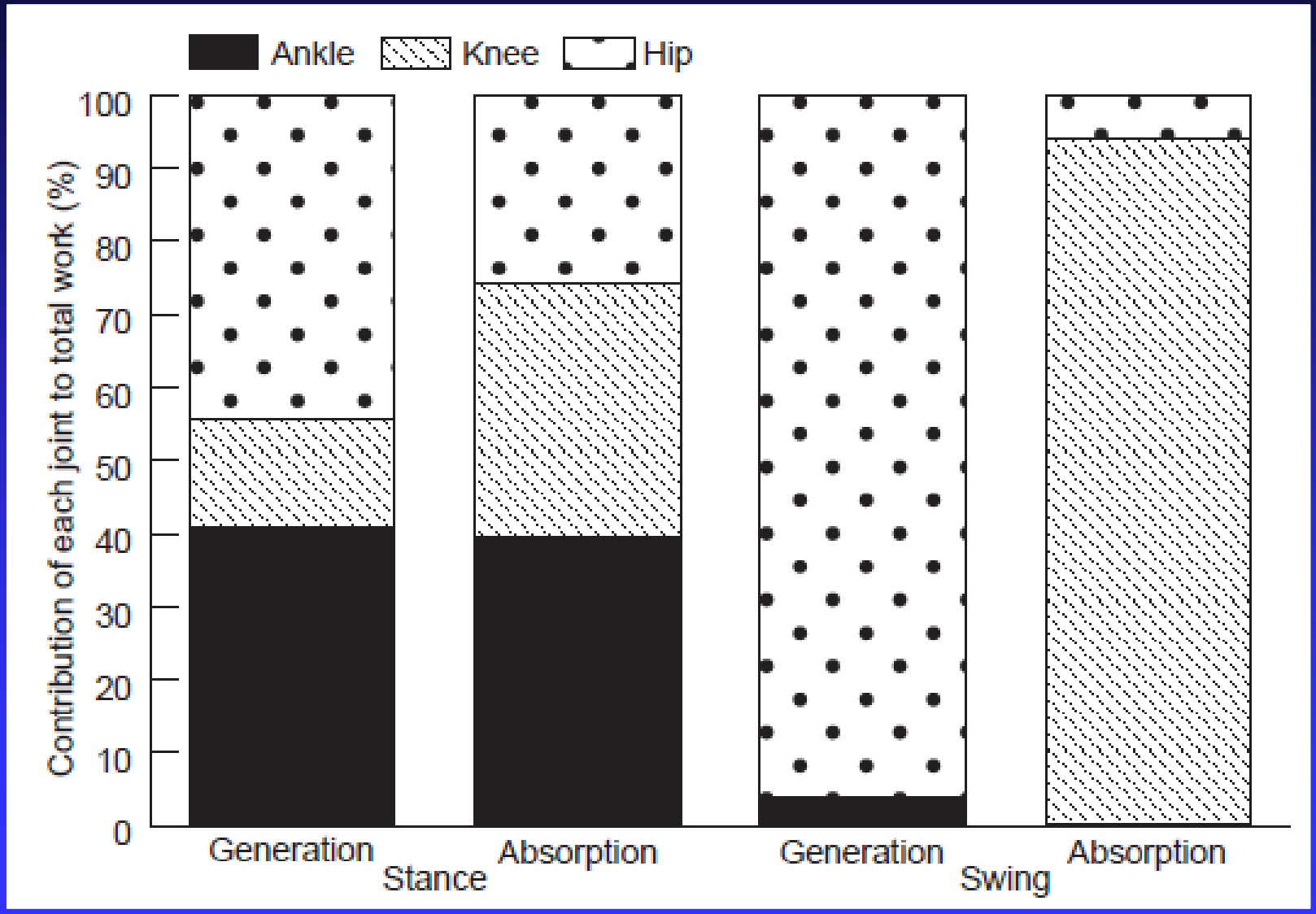
Hanley & Bissas, 2017





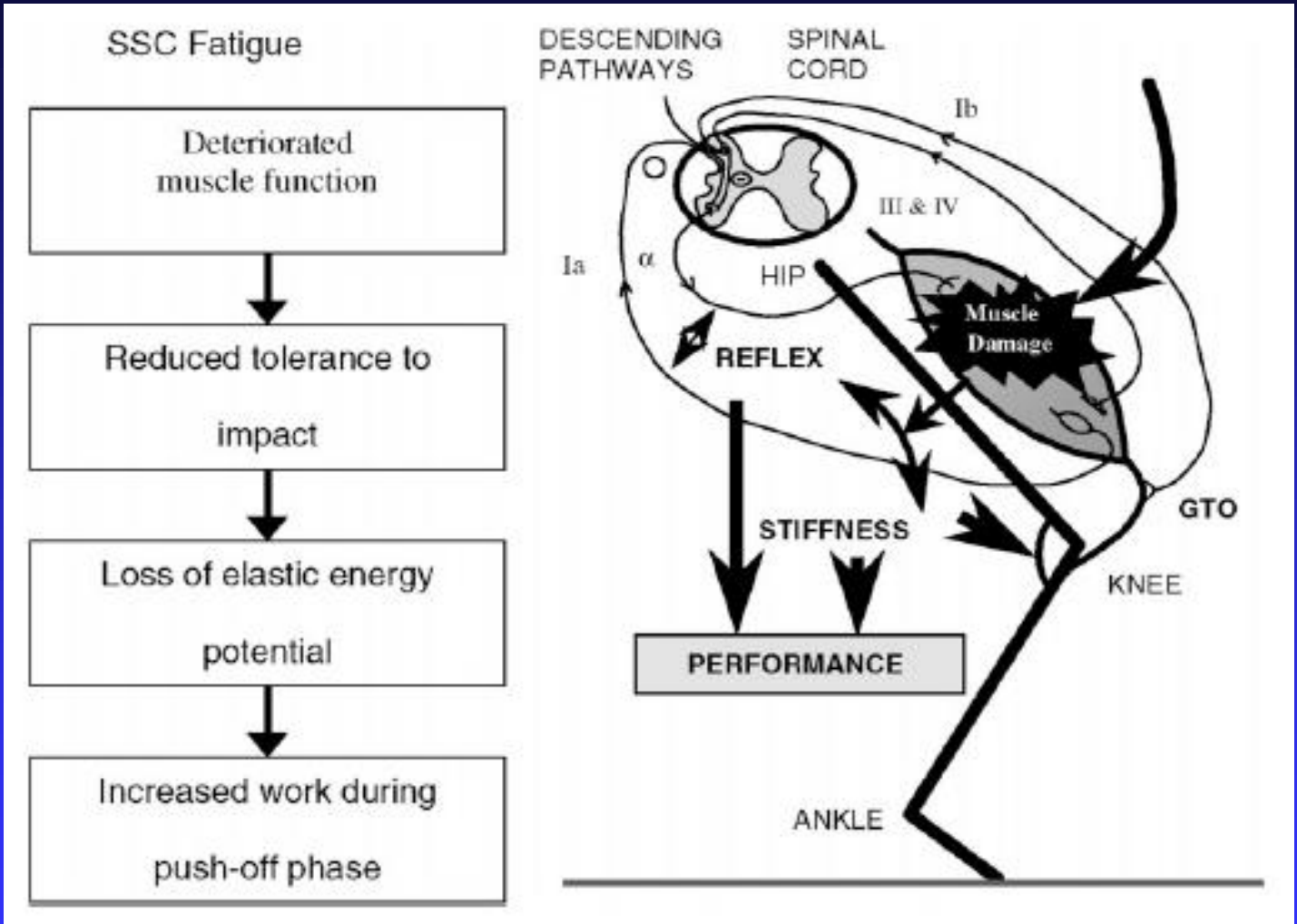
Laird (2000)

Energy contributions



Hanley & Bissas, 2017

Fatigue and elasticity



Komi, 2000

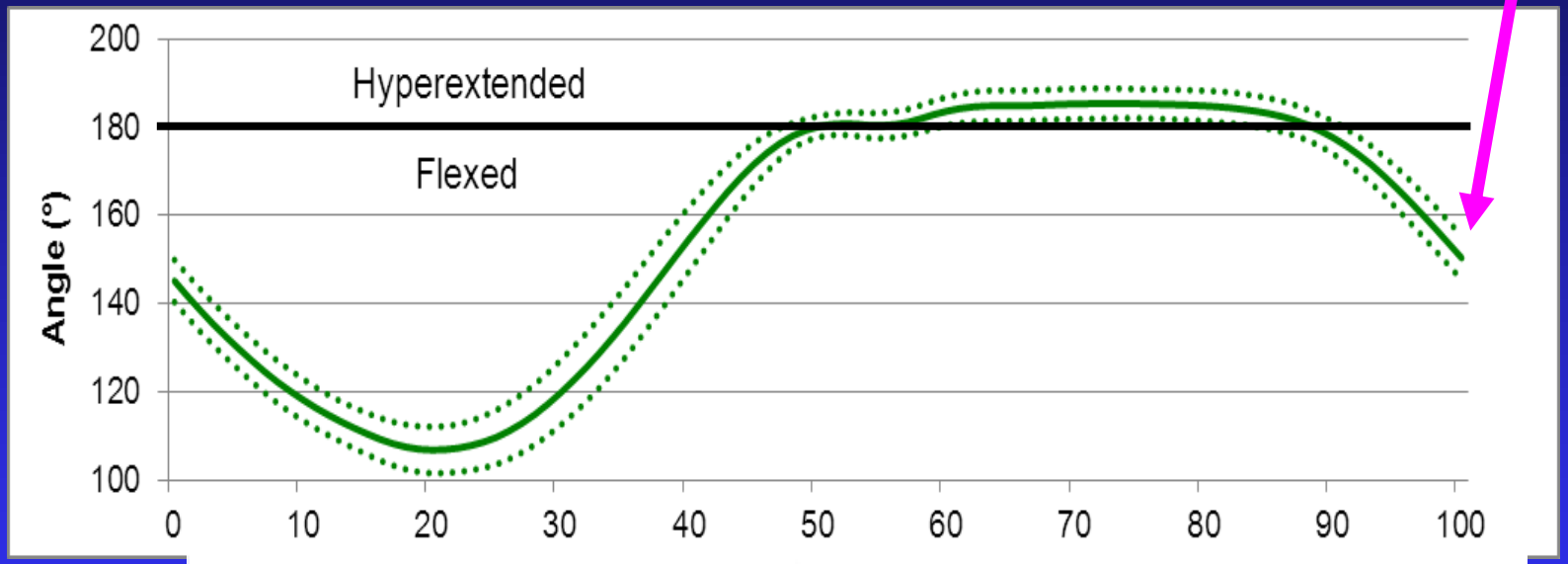
Kinematic changes with fatigue

- Even though world-class 50 km race walkers experience considerable decreases in pace after 30 km (Hanley, 2013), their cadence values do not decrease (Hanley et al., 2013). It is possible that this is evidence of endurance athletes who have trained to maintain regular muscle firing rates, and that the main effect of fatigue was decreased muscle forces that imparted smaller propulsive impulses, and consequently led to reduced step length.

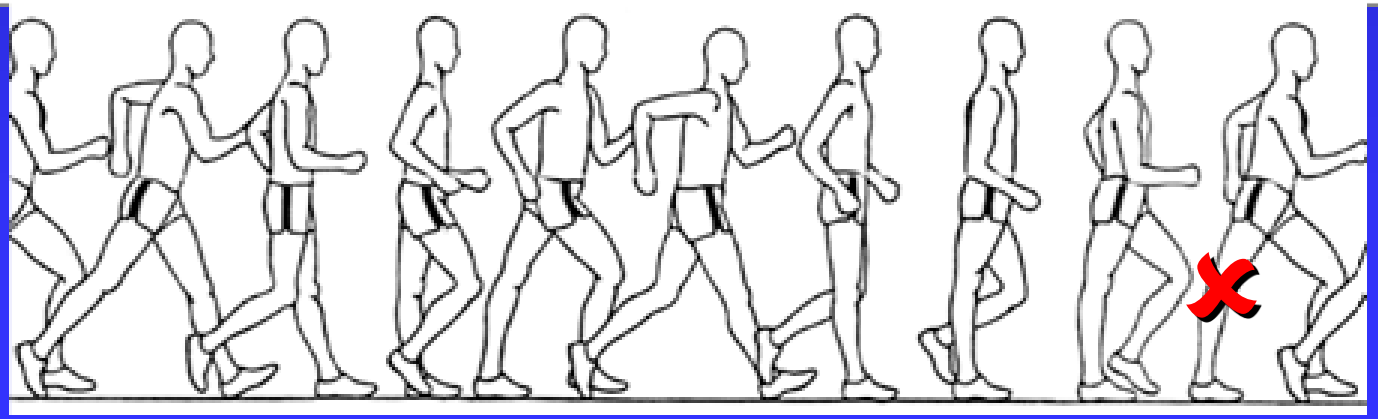
	Speed ($km \cdot h^{-1}$)	Step length (m)	Cadence (Hz)
18.5 km	14.11 ($\pm$0.61)	1.25 ($\pm$0.05)	3.14 ($\pm$0.08)
28.5 km	14.15 ($\pm$0.60)	1.24 ($\pm$0.04)	3.16 ($\pm$0.09)
38.5 km	13.98 ($\pm$0.76)	1.23 ($\pm$0.05)	3.16 ($\pm$0.11)
48.5 km	13.43 ($\pm$0.71)	1.20 ($\pm$0.05)	3.12 ($\pm$0.13)
Difference (%)	+0.3, −1.2, −3.2	−0.8, −0.8, −2.4	+0.6, 0.0, −1.3
ANOVA	$\mathbf{F_{1.71,18.76} = 9.35}$	$\mathbf{F_{3,33} = 10.88}$	$F_{3,33} = 1.91$
	$\mathbf{P = 0.002}$	$\mathbf{P < 0.001}$	$P = 0.147$
	$\mathbf{\eta_p^2 = 0.46}$	$\mathbf{\eta_p^2 = 0.50}$	$\eta_p^2 = 0.15$

The right amount of knee flexion

You can see in the graph below that the knee flexes during the last 10% of stance to about 150°

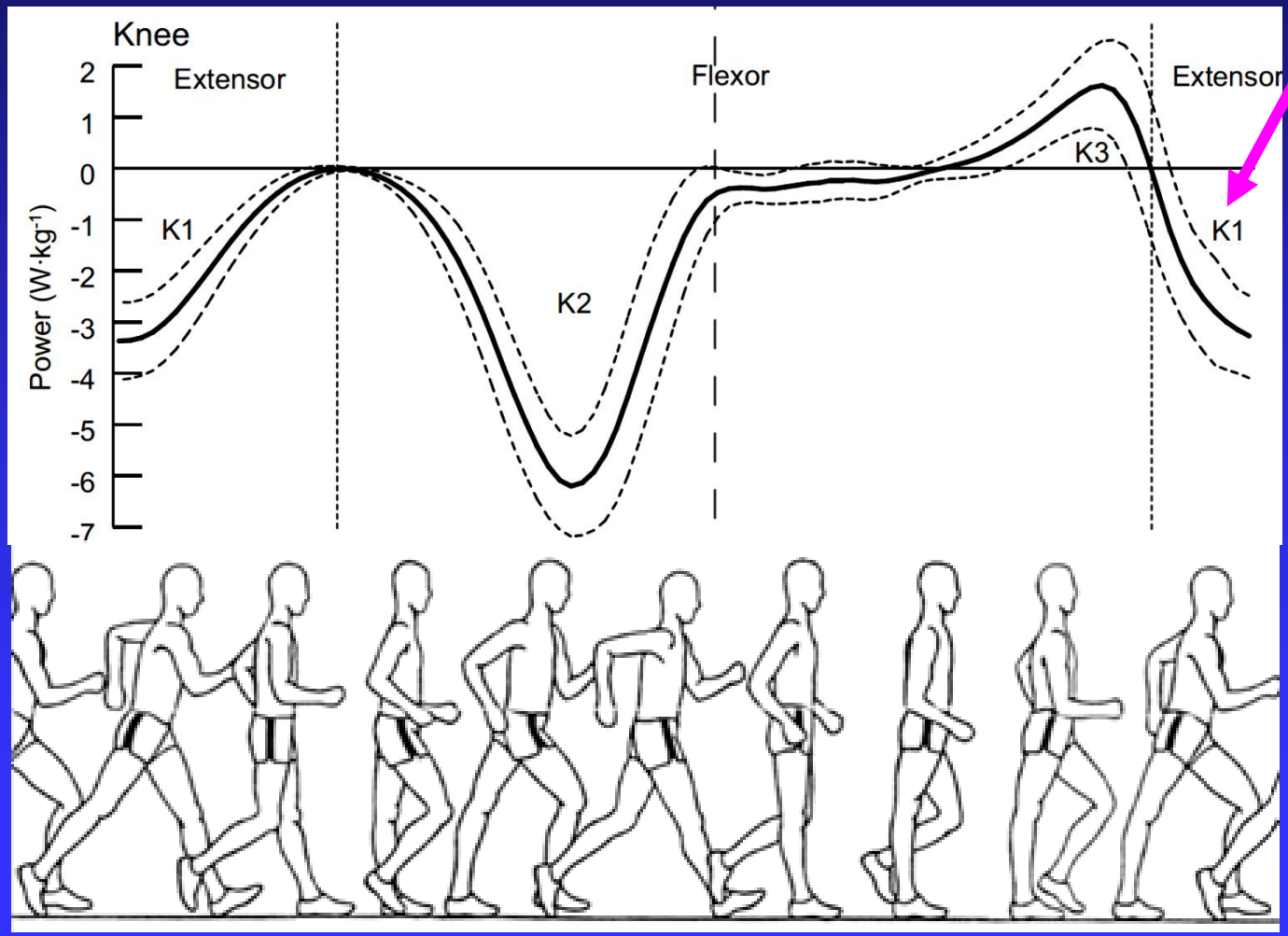


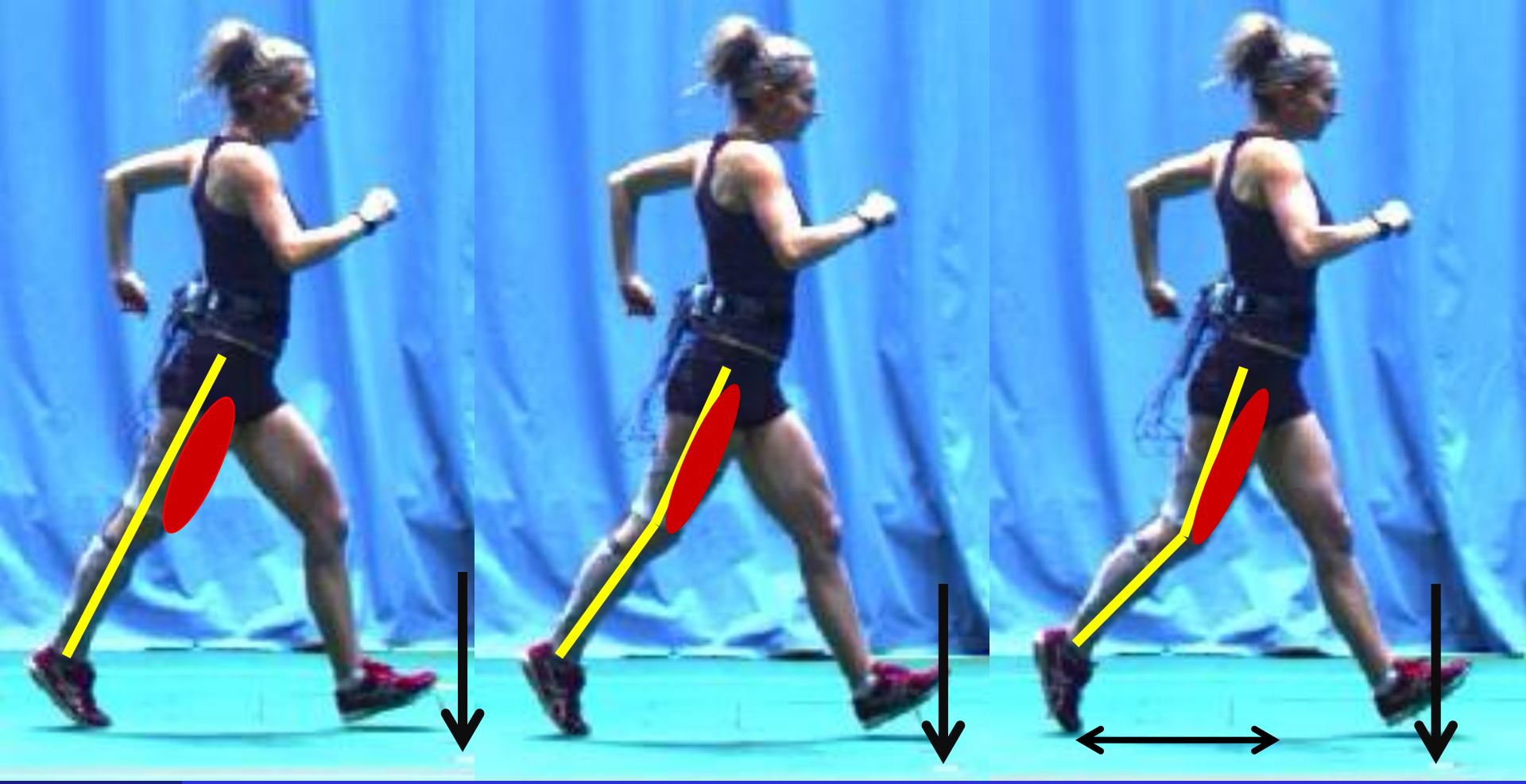
Hanley & Bissas, 2013



Restraint of knee flexion

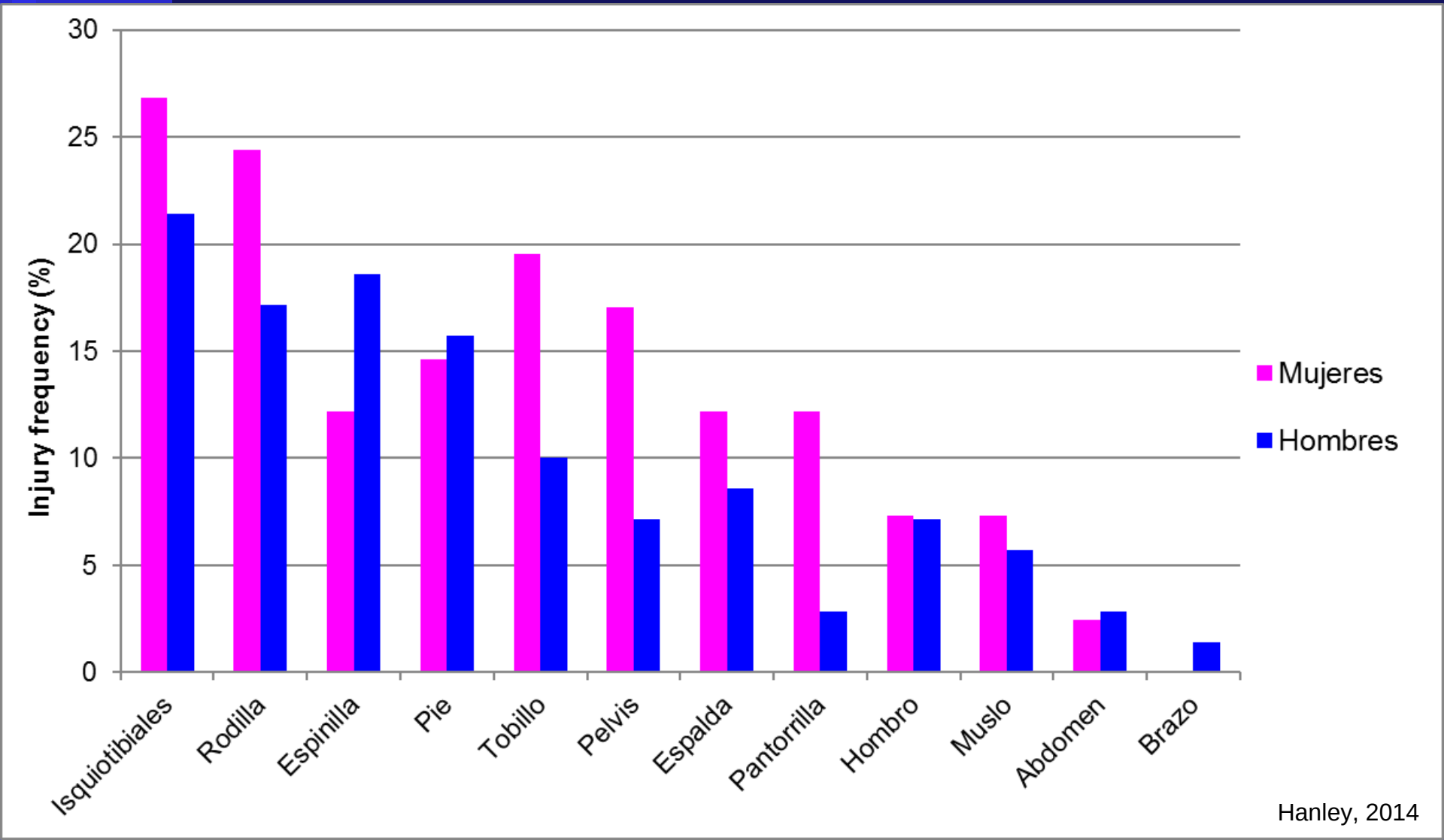
The knee is restrained from flexing too much so that it is easier to straighten it again at contact.





The knee movement late in stance allows the foot behind distance to be larger, causes a stretch of the knee extensors which help restrain flexion during early swing, and gives more time for the athlete to increase foot ahead.

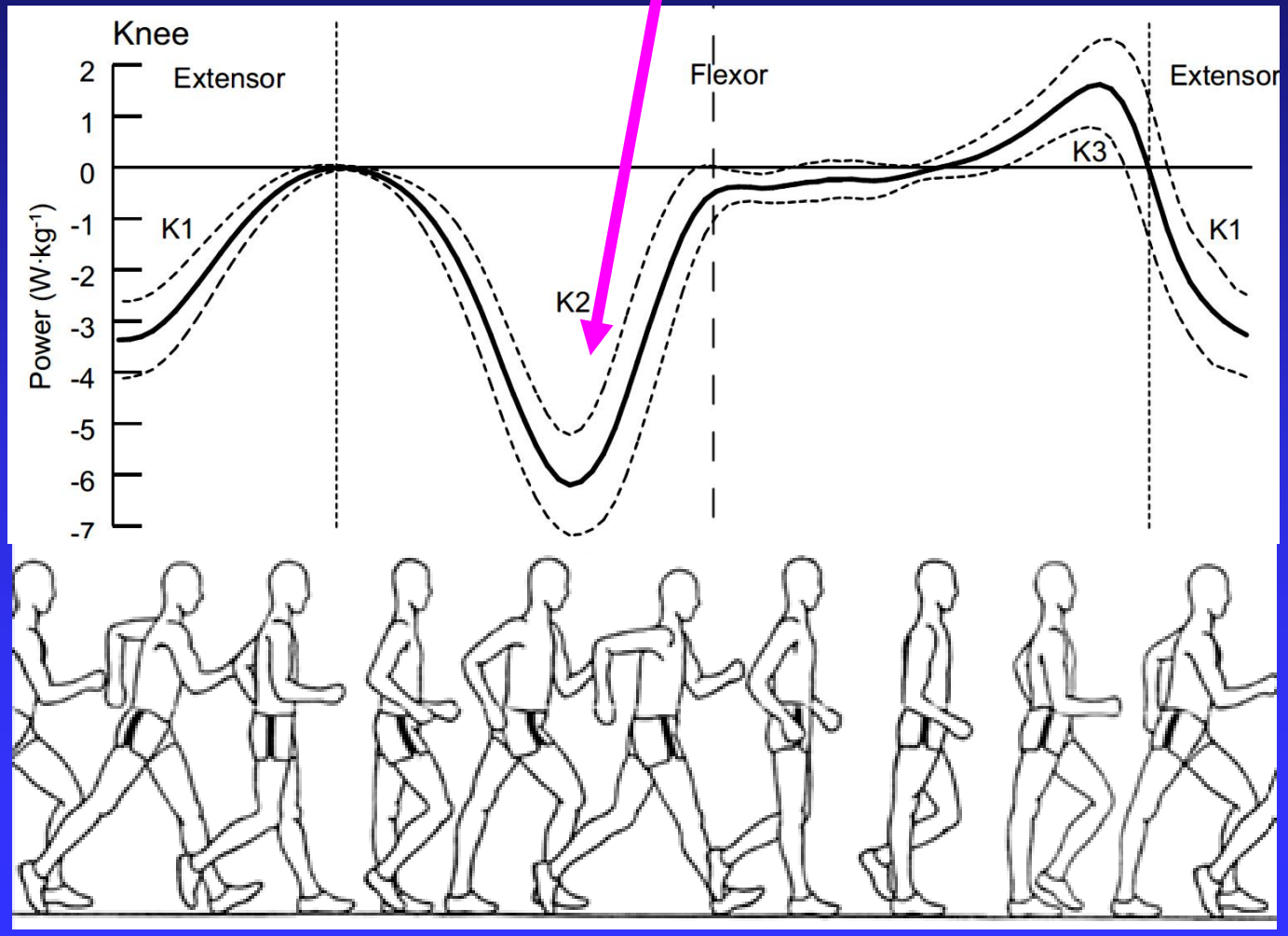
Q. Where have you suffered an injury…?



Hanley, 2014

Hamstrings - eccentric action

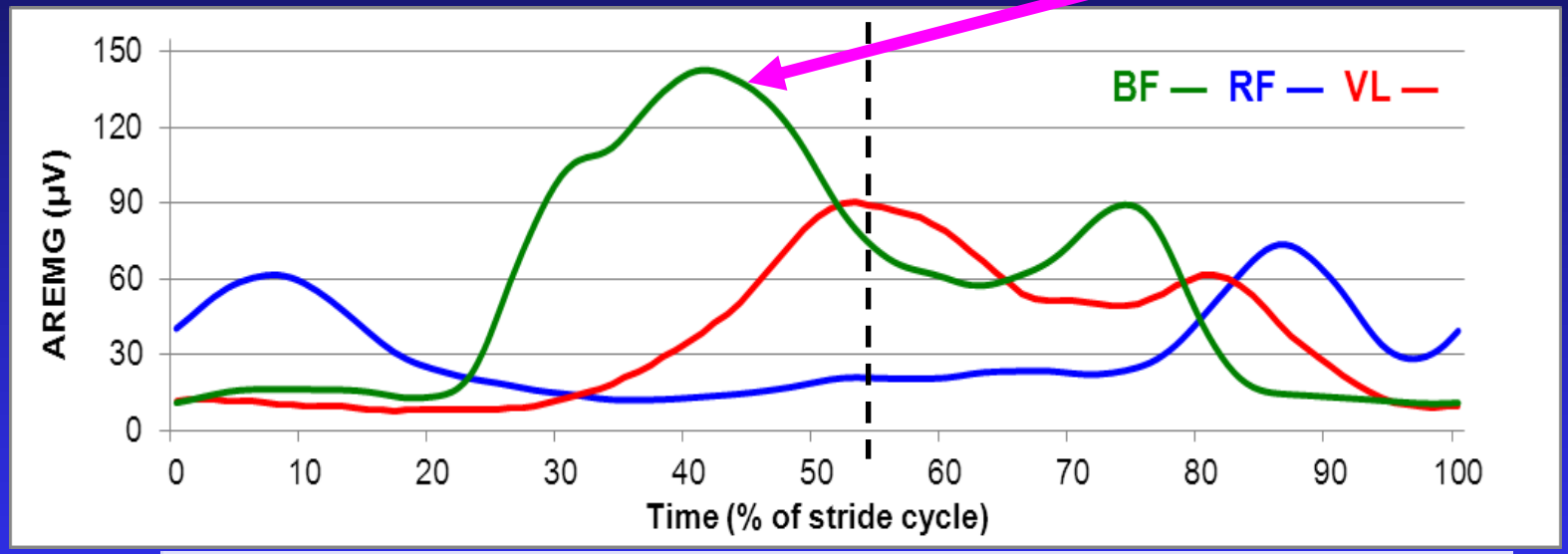
I have measured the amount of energy absorbed by the knee muscles during swing.

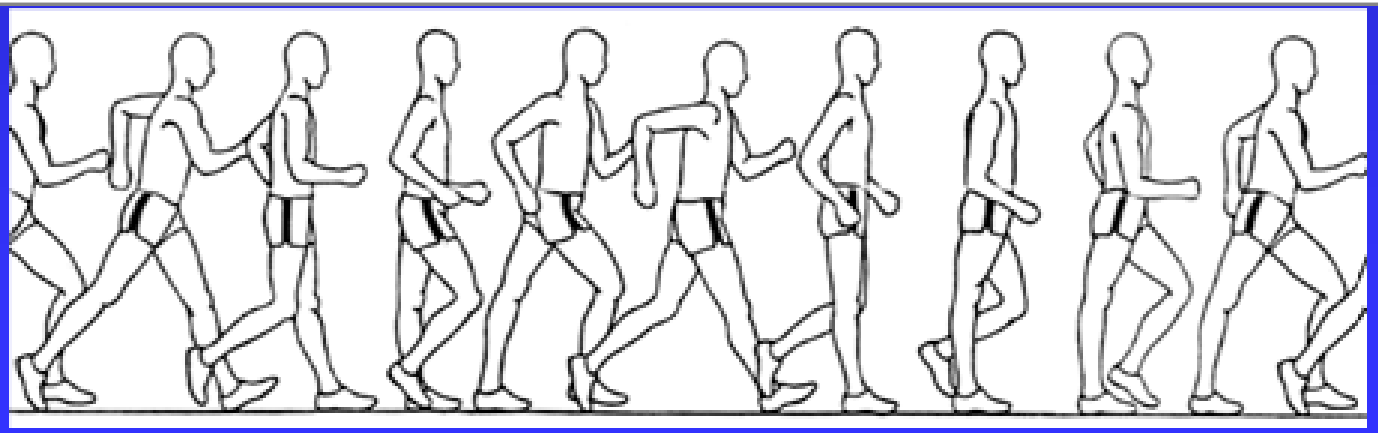


Hanley & Bissas, 2017

Hamstring activity

I measured the activity of the biceps femoris muscle – note its activity during late swing.

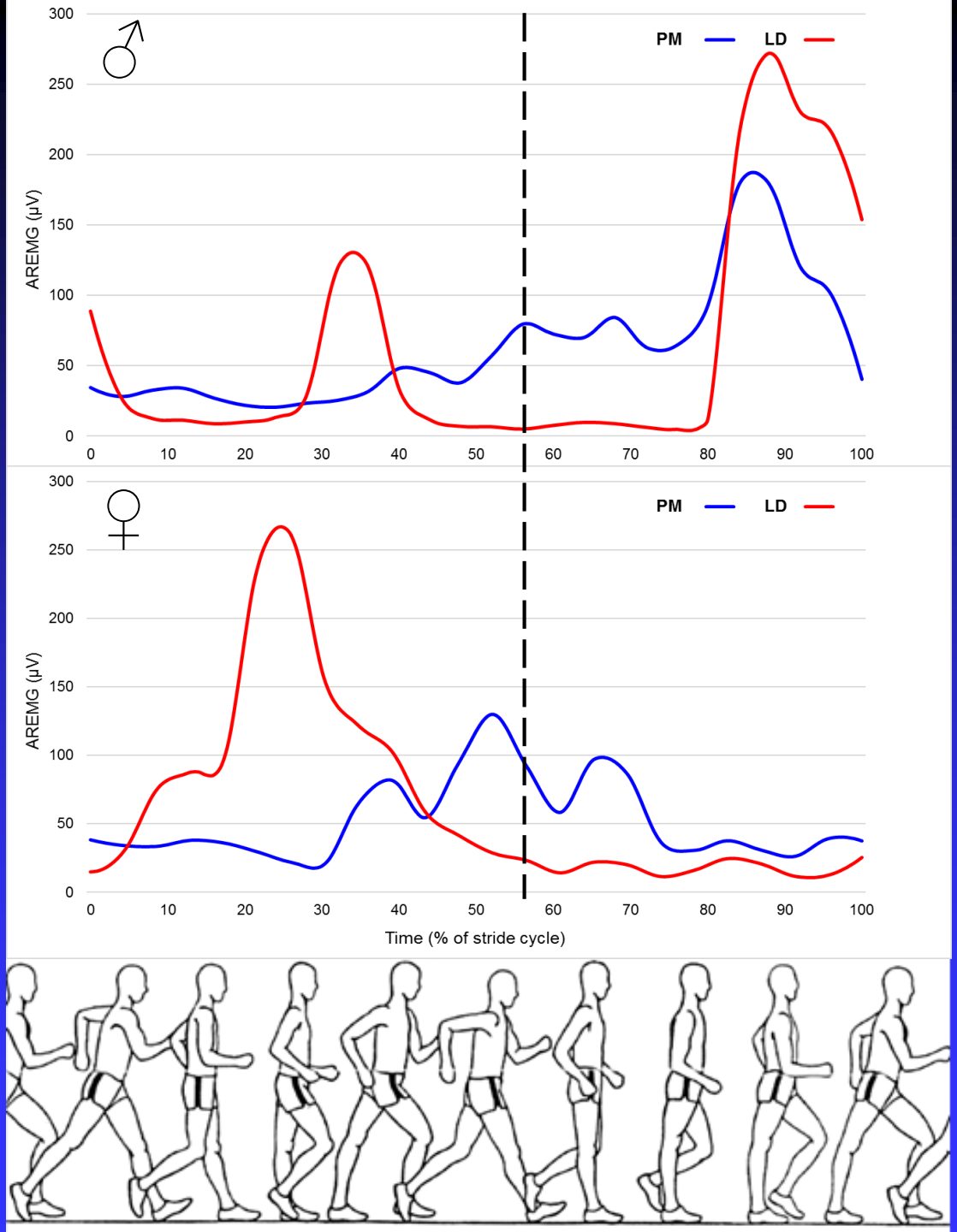




New studies on upper body

Pectoralis major

Latissimus dorsi


♂
PM
LD
AREMG (μV)
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
♀
PM
LD
AREMG (μV)
Time (% of stride cycle)

The need for speed

- At elite standard, race walking is an elastic activity which requires speed to be effective. Coaches should be cautious about adopting drills at a slow speed in trying to emphasise movements which cannot be replicated once the athlete moves at race speed.
- Such low level drills may however be useful for beginners when learning correct technique.
- Many injuries are caused by excessive strain on the muscles during fast movements that need to be strengthened to withstand these forces.

Thank you for your attention!

References

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