The Effect of Tether Speed on Muscle Activation and Recruitment Patterns

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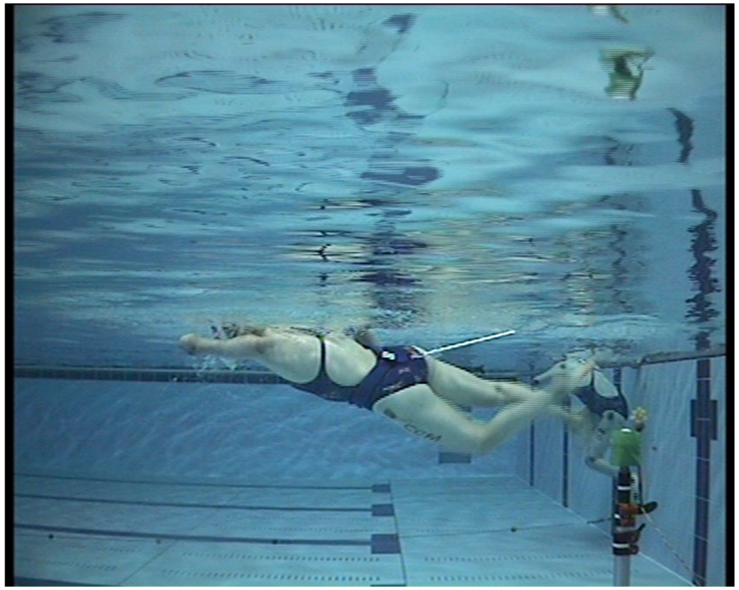
INTRODUCTION

- Power can be defined as the rate at which work is done by a muscle or group of muscles (Knudson, 2009).
  - Swimming speed is highly dependent on the swimmer's ability to produce enough power to overcome drag.
- No standardised test to monitor power development in swimmers.
- The most well established swimming ergometer is the swim bench (Swaine, 2000).
- Movement on the swim bench does not elicit the same muscle activation levels and coordination patterns as free swimming (Olbrecht & Clarys, 1983).

INTRODUCTION

- Fully tethered swimming presents a high level of muscle specificity to free swimming (Bollens et al., 1988).
- Semi-tethered swimming (Costill et al., 1986):
  - Higher ecological validity than fully tethered swimming.
  - Calculate power (Force x Velocity).



- Muscle specificity when swimming on semi-tethered ergometers has not been examined.

AIMS AND HYPOTHESES

Aims

- Establish whether: 1) muscle activity and, 2) muscle recruitment patterns differ between free swimming

  and semi-tethered swimming, at various tether speeds.

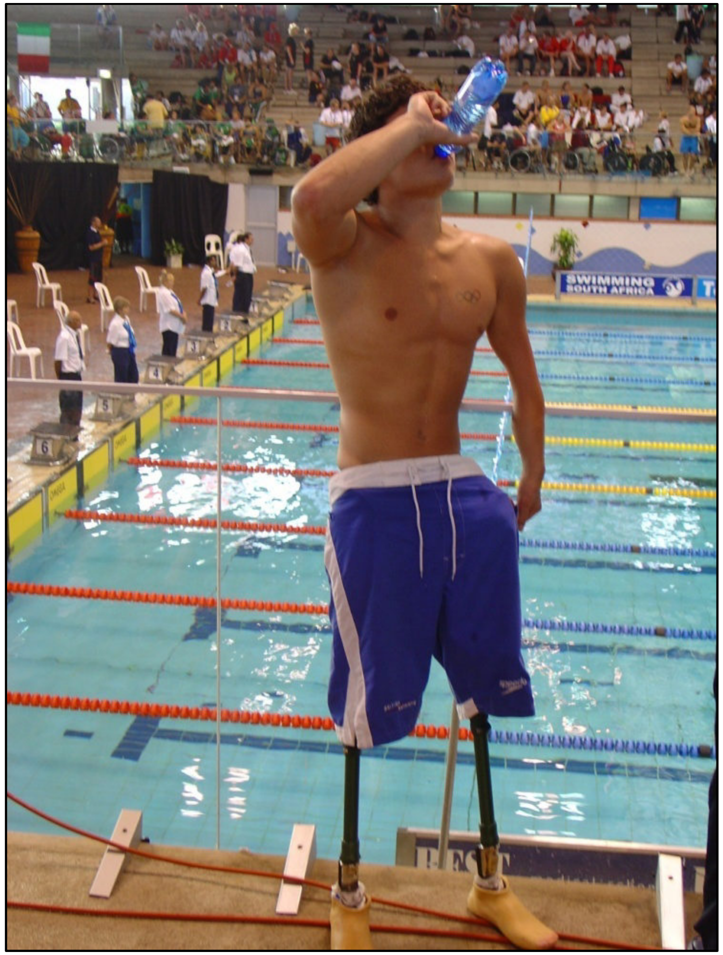
Hypotheses

- As tether speed increases: 1) the level of muscle activity and, 2) muscle recruitment patterns will match more closely to those found during free swimming.

METHOD

Participants

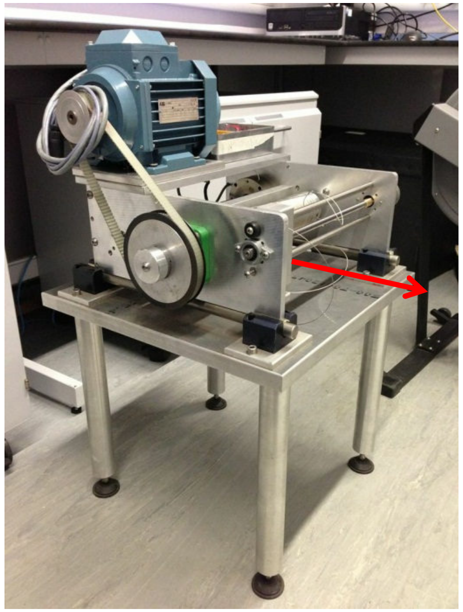
- Five highly trained male swimmers with a physical impairment (age 25.4 ± 6.7 years; height 1.58 ± 0.28 m; mass 69.0 ± 14.7 kg).
- Each swimmer represented a different IPC Class (S5, S6, S8, S9, S10).
- Members of the British Disability Swimming World Class programme.



METHOD

Calculation of Power

- Isokinetic Tethered Swimming (ITS) Ergometer.
  - Feeds an inelastic tether out at a predetermined speed.
  - Swimmers are attached via a waist belt.
  - Power (W) = Tether force (N) × Tether speed ($m \cdot s^{-1}$).



Protocol

- Five maximum effort trials.
  - *Four* tether speeds: 0% (fully tethered), 30%, 50% and 70% of maximal swimming speed (SS_{MAX}).
  - *One* trial performed as free swimming.

BRITISH SWIMMING

METHOD

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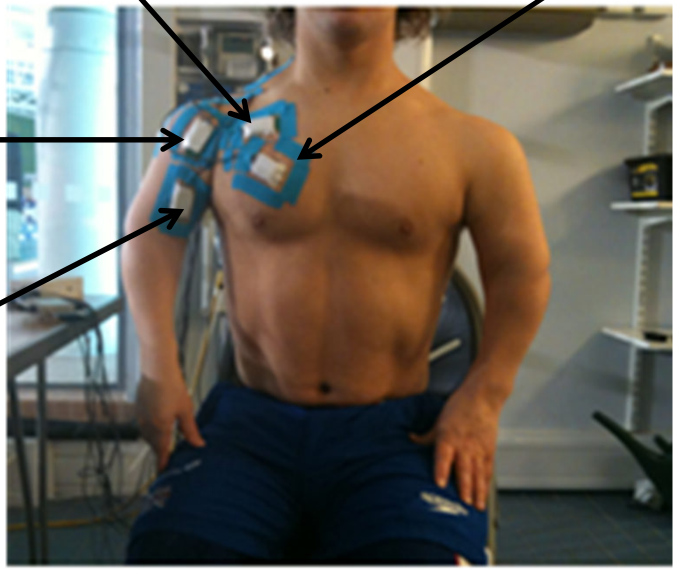
Electromyography (EMG)

Pectoralis Major (clavicular portion)

Pectoralis Major (sternal portion)

Anterior Deltoid

Biceps Brachii

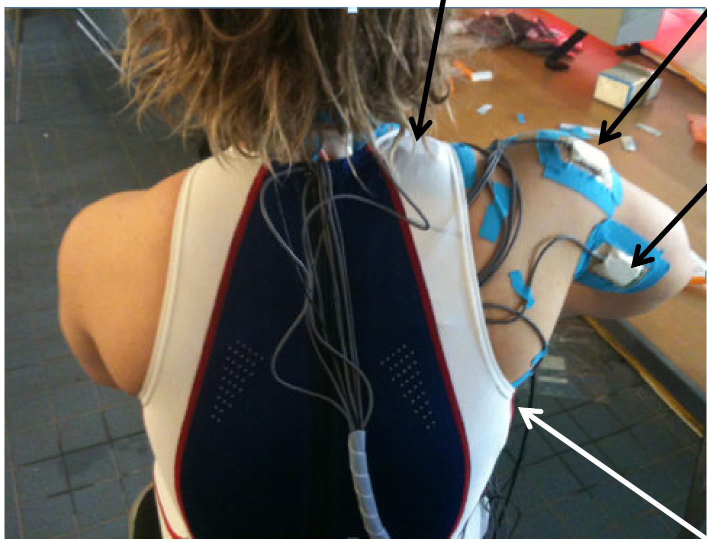


Trapezius (upper)

Posterior Deltoid

Ticeps Brachii (long head)

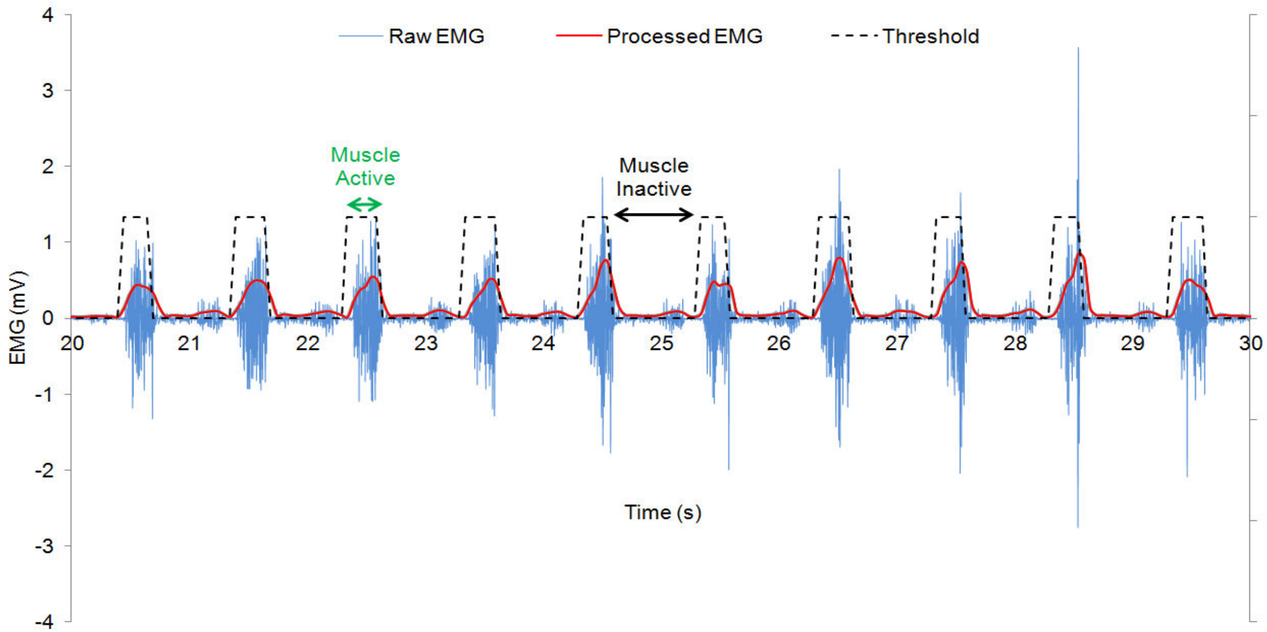
Latissimus Dorsi



METHOD

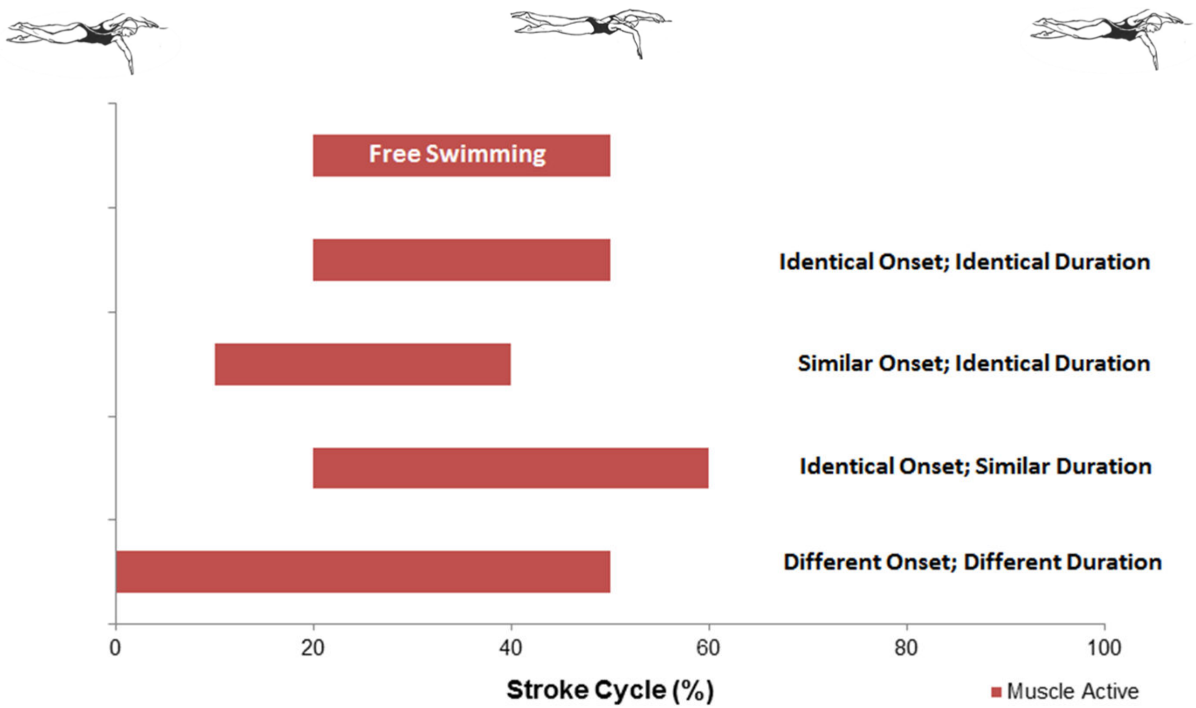
- **Muscle Activity**: Data were normalised as a percentage of the average peak activity recorded during the fully tethered trial.

- **Muscle Recruitment**: Threshold analysis was used to examine onset and duration of muscle activation.



METHOD

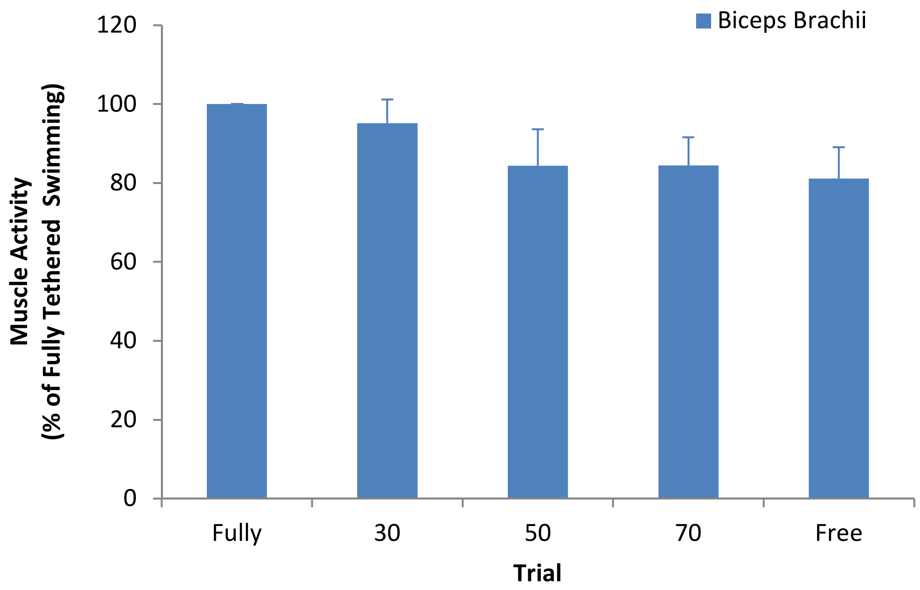
- Difference (%) in the onset and duration of muscle activation between free swimming and each tether speed setting.
  - Values were categorised as being either *identical* (0-5%), *similar* (5-10%) or *different* (>10%) to free swimming.

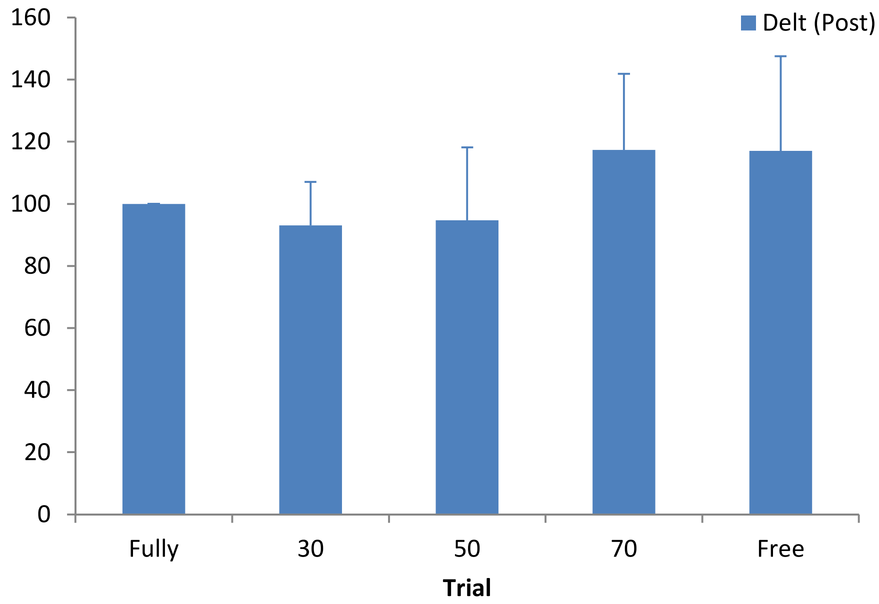


RESULTS

Muscle Amplitude

- As tether speed increased, muscle activity decreased (with the exception of the posterior deltoid and trapezius).
- Lowest muscle activity was recorded during free swimming.





RESULTS

Muscle Recruitment

- The onset and duration of muscle activations were *identical* or *similar* to free swimming.

	Percentage of Muscle Activations			
	Onset		Duration	
Trial	Identical %	Similar %	Identical %	Similar %
0% SS_{MAX}	62	38	77	23
30% SS_{MAX}	69	31	85	15
50% SS_{MAX}	69	31	62	38
70% SS_{MAX}	92	8	92	8

DISCUSSION

- The amplitude and muscle recruitment patterns elicited when swimming on the ITS Ergometer are highly specific to those during free swimming.
- Higher muscle activity at slower tether speeds is likely due to:
  - Restricted forward progression.
  - Greater proportion of the arm involved in propulsion.
- Tether speed of 70% SS_{MAX} elicited muscle amplitudes and recruitment patterns closest to those of free swimming.
- The ITS Ergometer is a suitable tool for training and monitoring power in swimmers with a physical impairment.

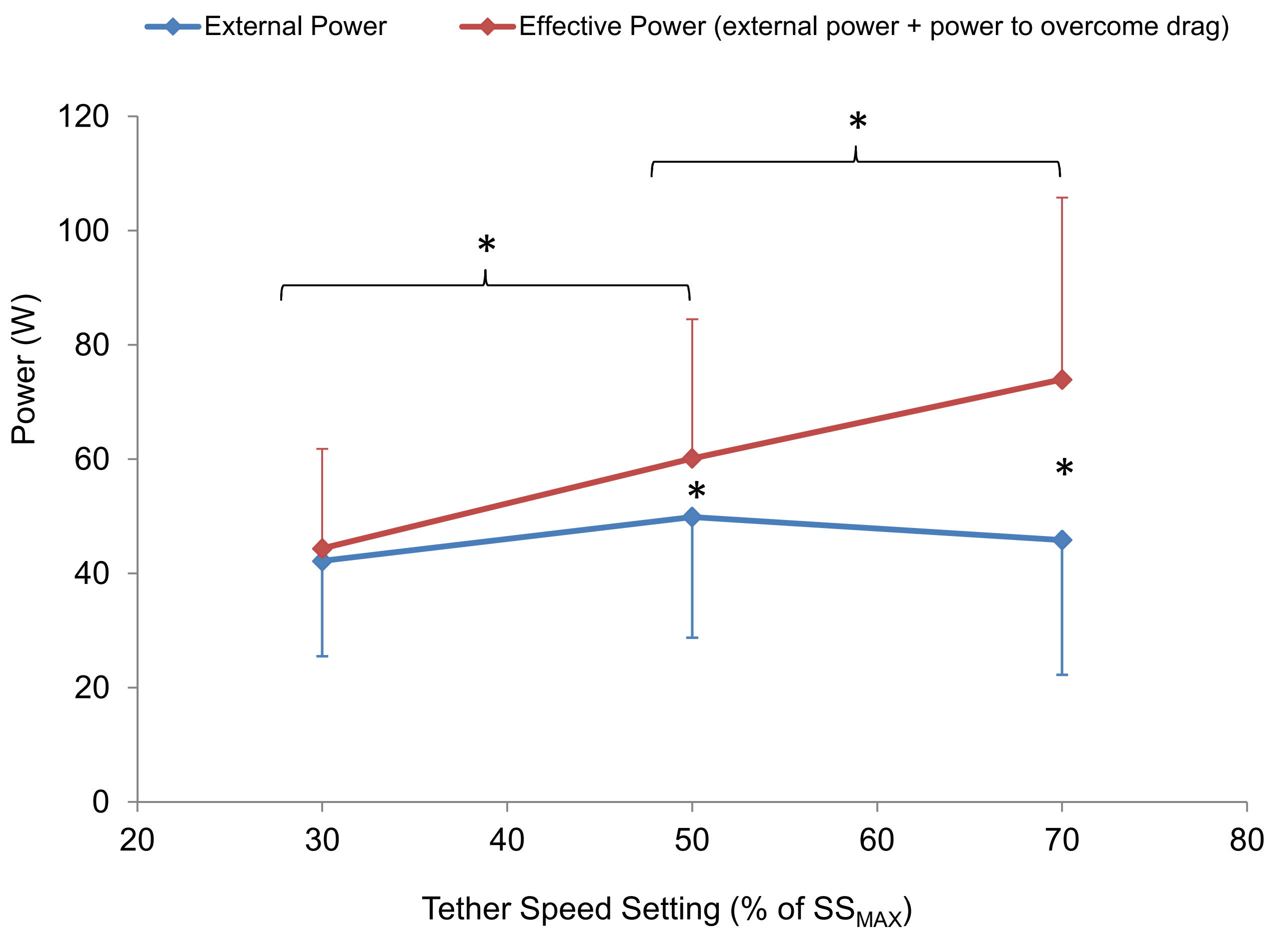
Any Questions?

REFERENCES

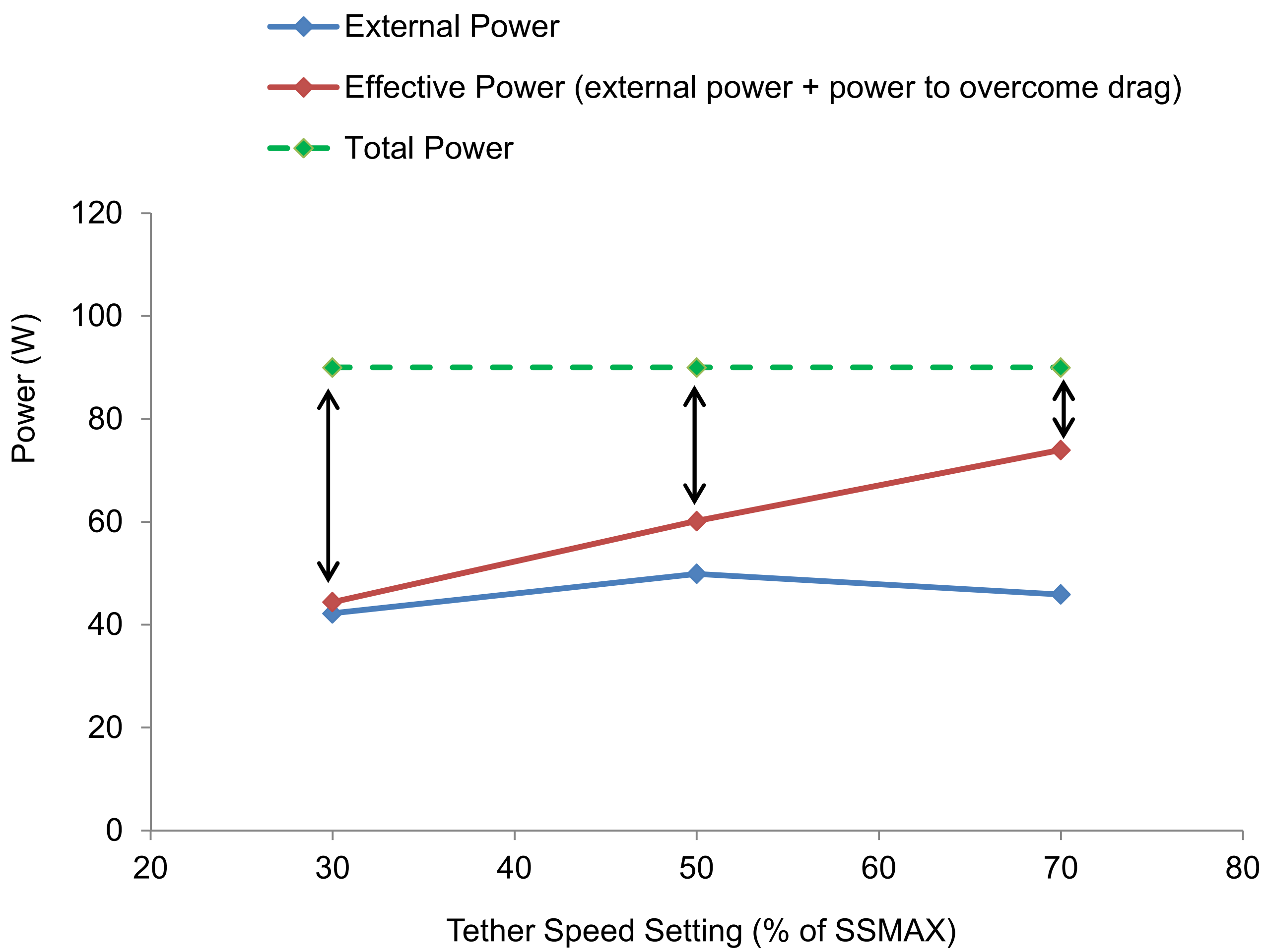
- Bollens, E., Annemans, L., Vaes, W., & Clarys, J. P. (1988). Peripheral EMG comparison between fully tethered and free front crawl swimming. In B. E. Ungerechts, K. Wilke & K. Reischle (Eds.), *Swimming Science V*. Champaign, ILLINOIS: Human Kinetics.
- Costill, D. L., Rayfield, F., Kirwan, J., & Thomas, R. (1986). A Computer Based System For The Measurement of Force and Power During Front Crawl Swimming *Journal of Swimming Research, 2*(1), 16-19.
- Knudson, D. V. (2009). Correcting the use of the term 'power' in the strength and conditioning literature. *The Journal of Strength and Conditioning Research, 23*(6), 1902-1908.
- Olbrecht, J., & Clarys, J. P. (1983). EMG of specific strength training exercises for the front crawl. In A.P. Hollander, P.A. Huijing & G. de Groot (Eds.), *Swimming IV* (pp.136-141). Baltimore: University Park Press.
- Shionoya, A., Shibukura, T., Koizumi, M., Shimizu, T., Tachikawa, K., Hasegawa, M., & Miyake, H. (1999). Development of Ergometer Attachment for Power and Maximum Anaerobic Power Measurement in Swimming. *Applied Human Science, 18*(1), 13-21.
- Swaine, I. L. (2000). Arm and leg power output in swimmers during simulated swimming. *Medicine and Science in Sports and Exercise, 32*(7), 1288 - 1292.

RESULTS

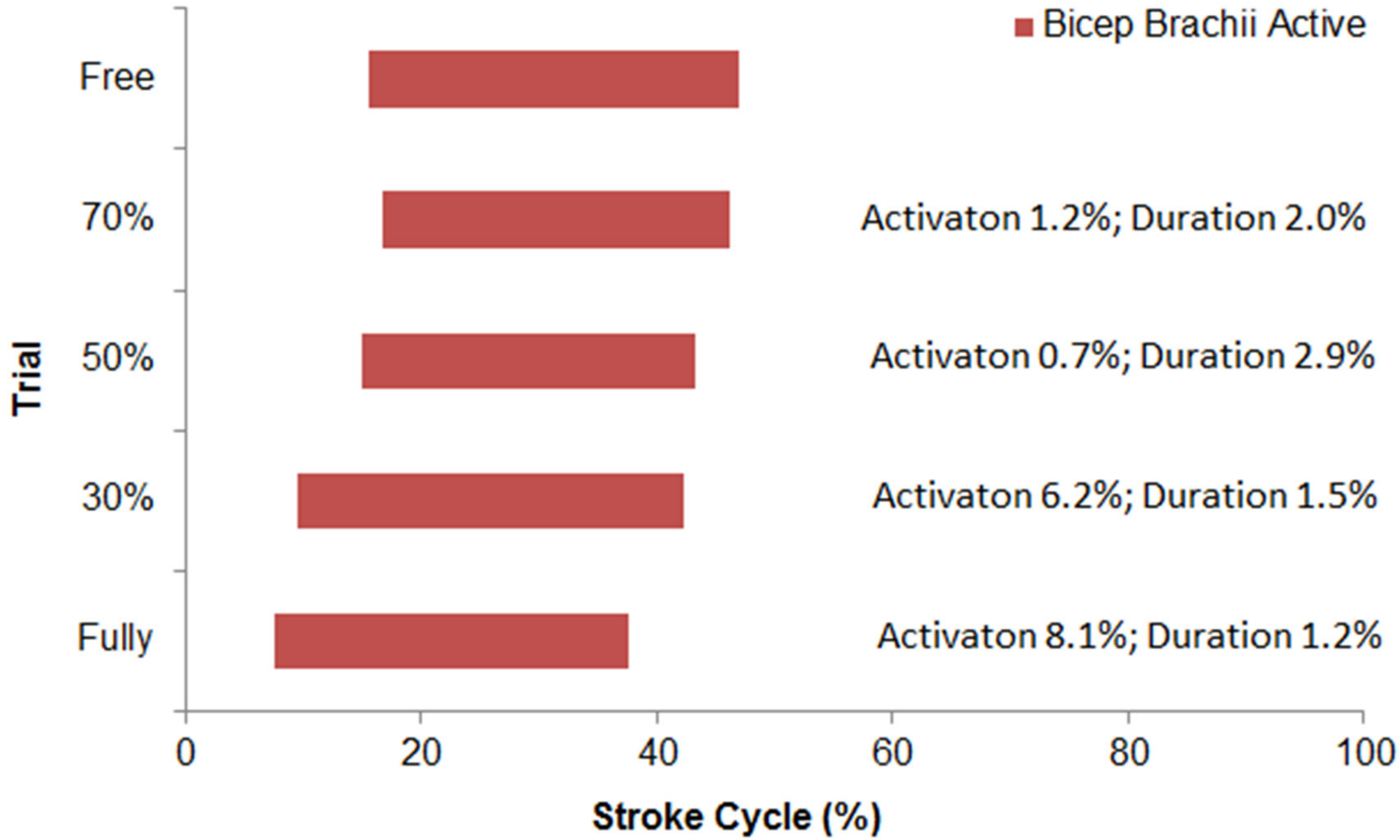
Power



Total Power

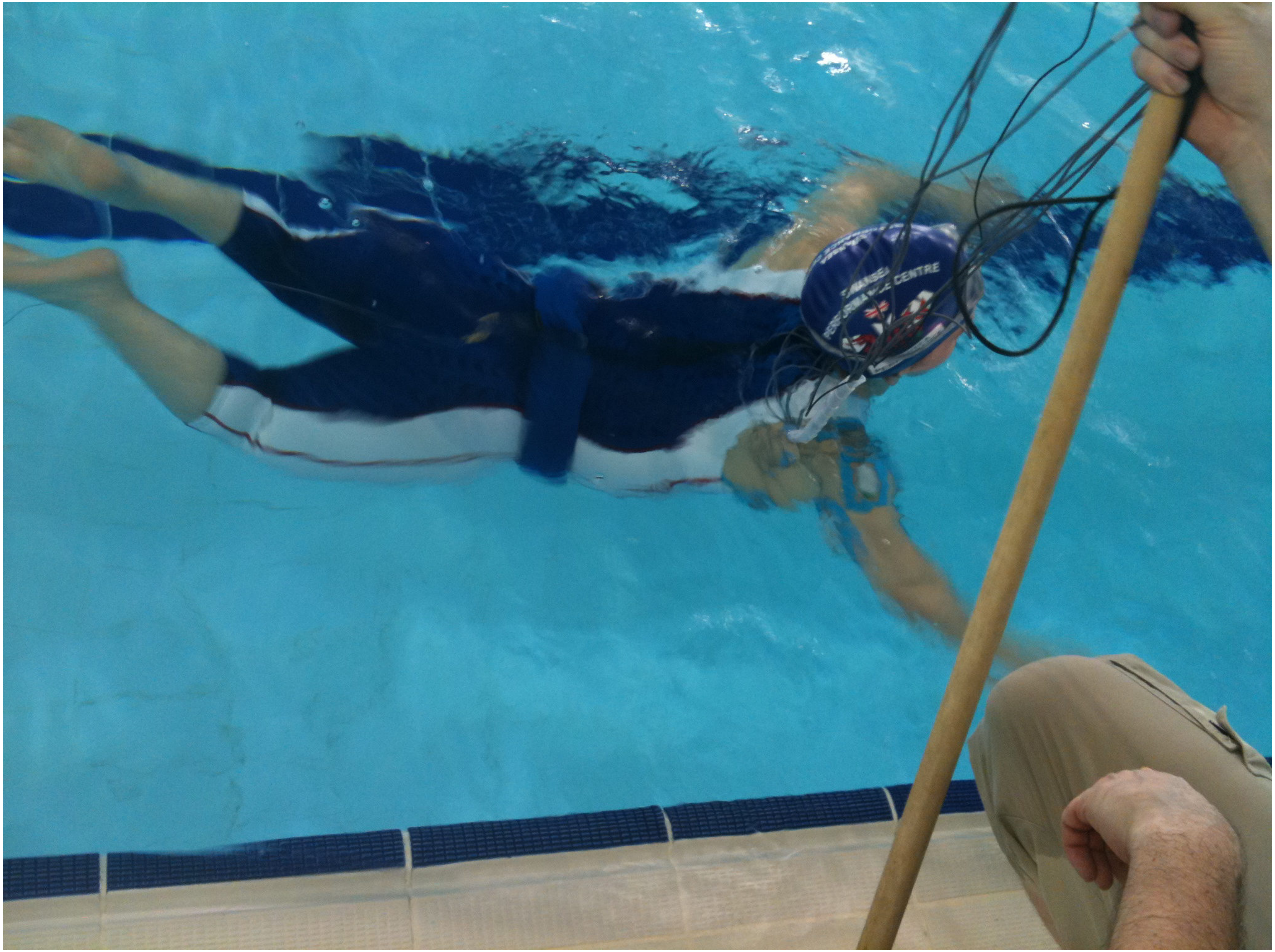

External Power
Effective Power (external power + power to overcome drag)
Total Power
Power (W)
0
20
40
60
80
100
120
20
30
40
50
60
70
80
Tether Speed Setting (% of SSMAX)

Threshold Analysis- Results



DISCUSSION

- Swimmers were asked to swim maximally in each trial.
  - Power should remain constant.
- Discrepancy between muscle amplitude and effective power may be due to the final element of power which was not accounted for; power lost to the water.
- Total Power = External + Overcome Drag + Lost to the Water
- During slower tether speeds the hand repeatedly pulls through the same fast flowing water.
- Assuming power output of the swimmer remained constant, it appears the slower the tether speed, the greater is the power lost to the water.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