Application of Critical Power in Endurance Sports

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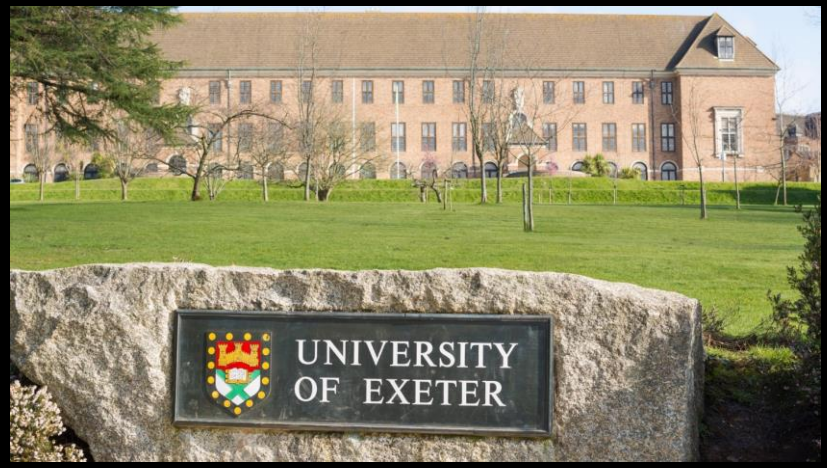
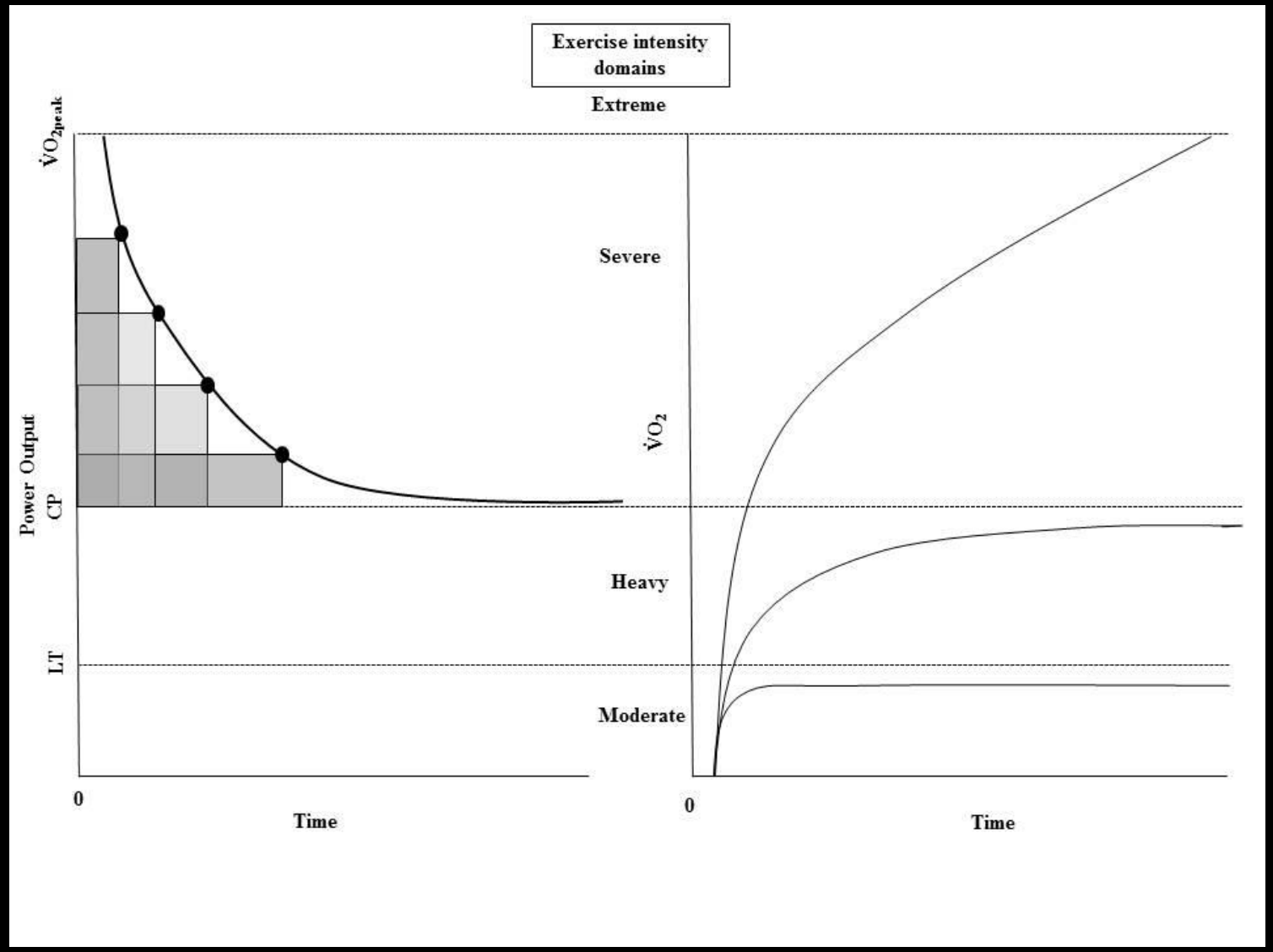


What is CP/CS and W’/D’?

- CP: Critical Power separates power outputs for which exercise tolerance can be sustained for long periods of time (>30min) from those that are predictably limited.

- W': Fixed amount of work that can be done above CP. Therefore, tolerance for exercise performed above CP is limited by the power output sustained above CP and the size of W'.

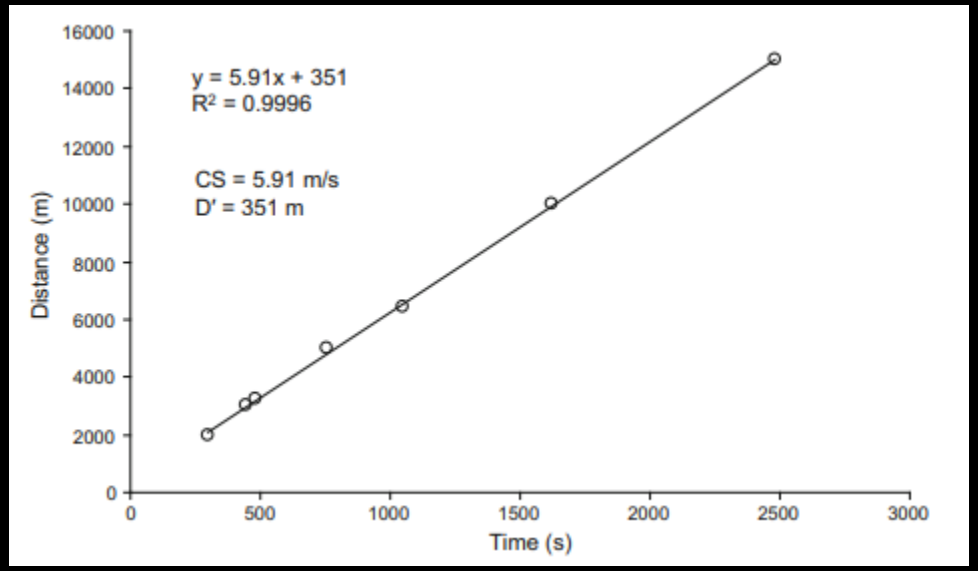

Exercise intensity domains
Extreme
$\dot{V}O_{2peak}$
Severe
Power Output
CP
$\dot{V}O_2$
Heavy
LT
Moderate
0
Time
0
Time

How to estimate CS/CP

- Conventional Method
- 3-min all-out test

Conventional Method

- Performance best times
- Perferible 2-12min in length



Jones AM, Vanhatalo A (2017). The “Critical Power” Concept: Applications to Sports Performance with a Focus on Intermittent High-Intensity Exercise. *Sport Med* 47(s1): 65–78.

3-min all-out test

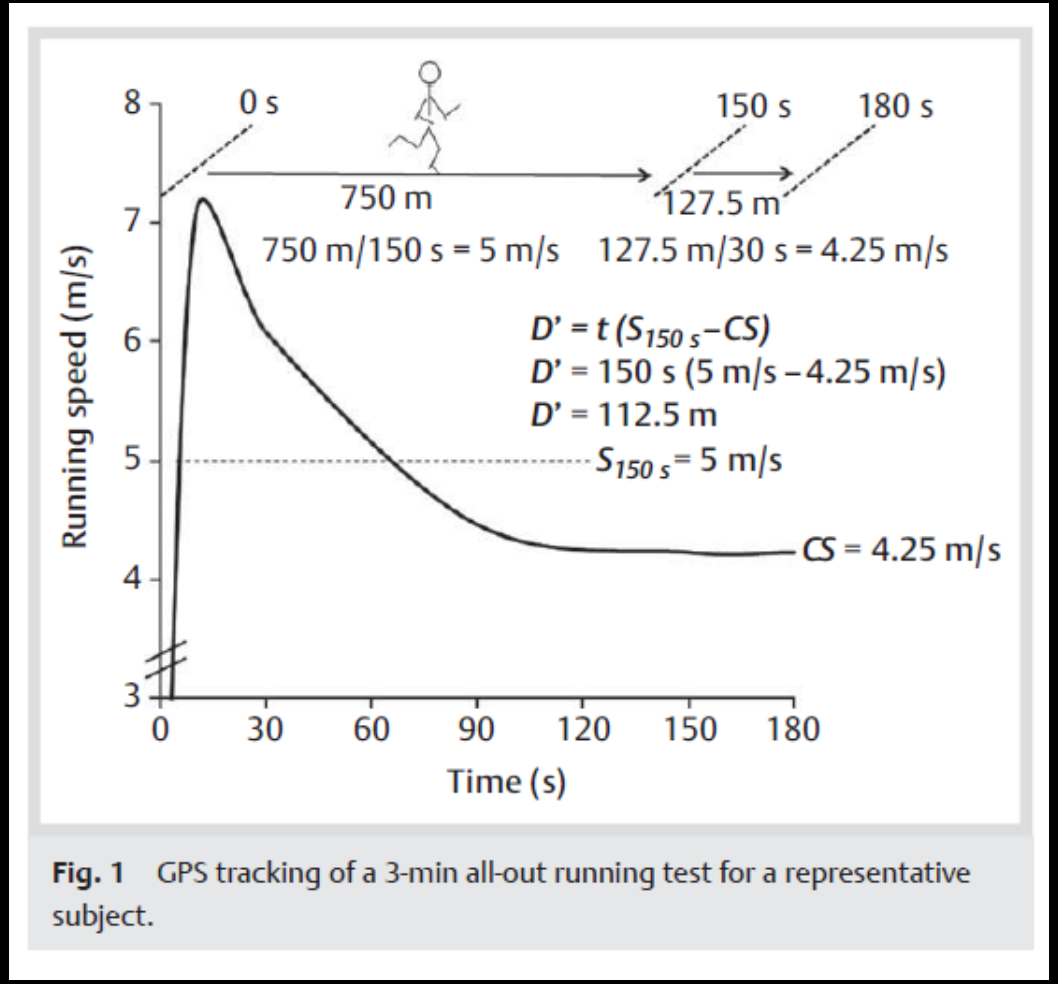


Fig. 1 GPS tracking of a 3-min all-out running test for a representative subject.

Pettitt, RW, Jamnick, N, and Clark, IE. 3-min All-out exercise test for running. Int J Sports Med 33: 426–431, 2012.

Performance best calculations (~2-30min)

Running

CS = average velocity of the last 30s

D´ = 150 s (V_{150s} – *CS*), where V_{150s} is the average velocity for the initial 150 s

t_{LIM} = (D - *D´*) / CS

V = (*D´* / t_{LIM}) + CS

Biking

CP (W)= average Power (W) of the last 30s

W´ (J) = 150 s (P_{150s} – *CP*), where P_{150s} is the average Power for the initial 150 s

t_{LIM} = *W´* / (P - CP)

P = (*W´* / t_{LIM}) + CP

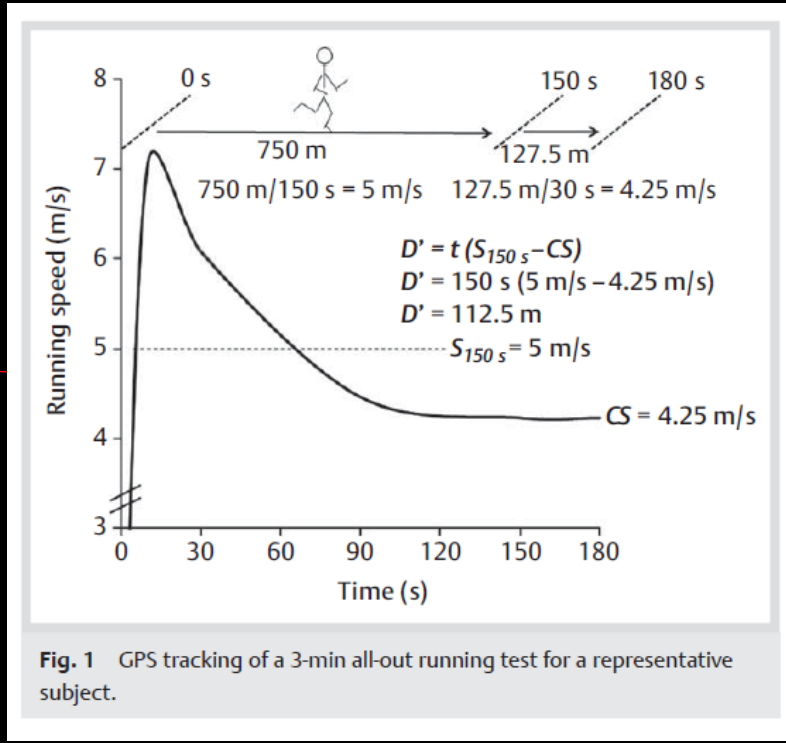


Fig. 1 GPS tracking of a 3-min all-out running test for a representative subject.

At what speeds can we run long distances?

- We normally exercise around 85% of CS depending on how fit we are.

- 2017 a study looked at 12 elite marathon runners' and concluded that the athletes were running marathon distances at a submaximal speed around 96% (93-100%) of their CS. Jones AM, Vanhatalo A (2017). The "Critical Power" Concept: Applications to Sports Performance with a Focus on Intermittent High-Intensity Exercise. *Sport Med* 47(s1): 65–78.

Interval calculations

Intervals

$V = [(D' \times \%) / t_{LIM}] + CS$,

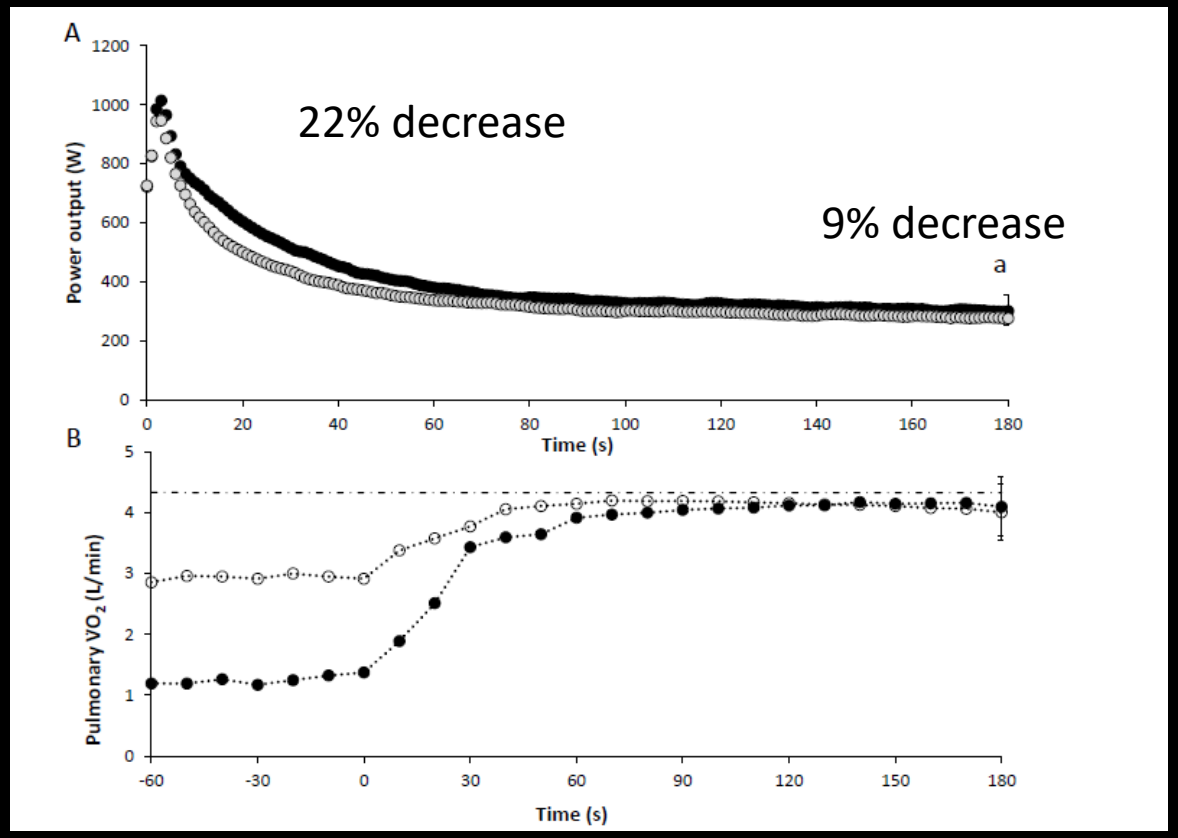
$INT_t = [D – (D' \times \%)] / CS$, and

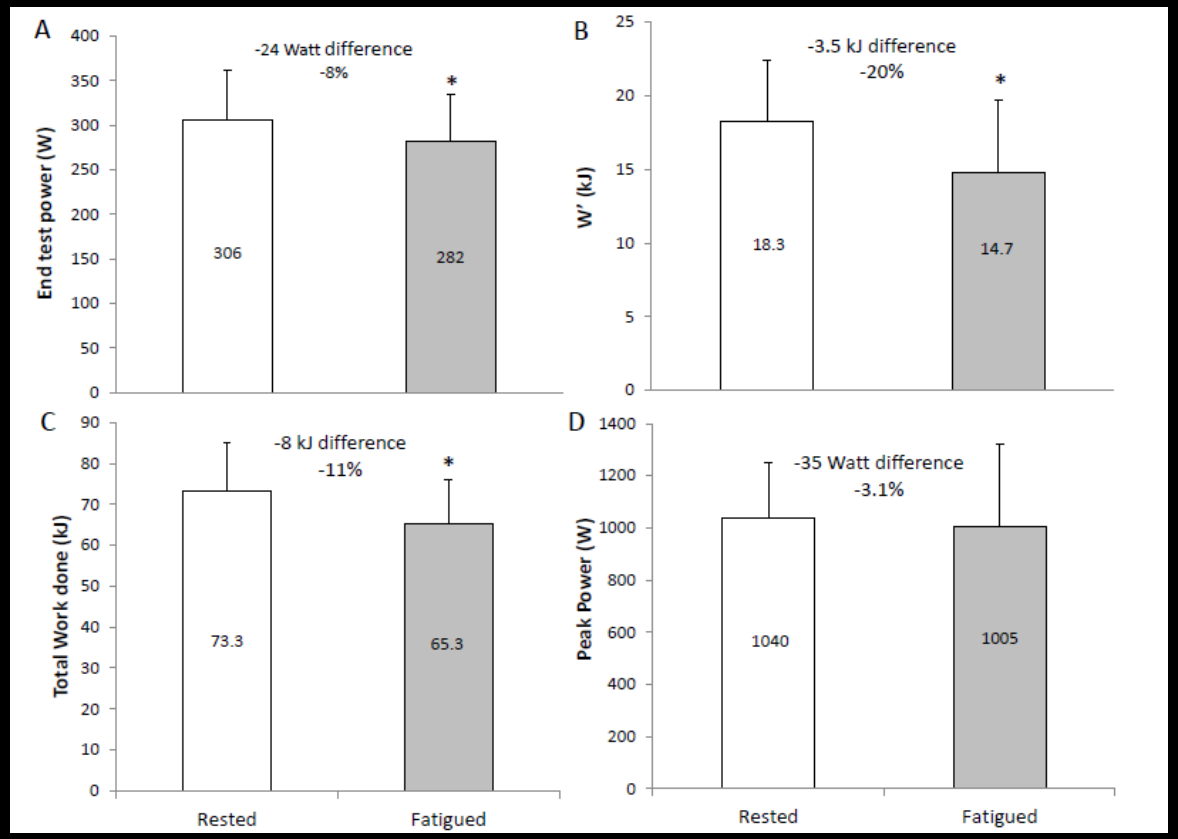
$INT_t = (D' \times \%) / (V – CS)$,

where V is velocity, INT_t is interval time, D is distance, and t_{LIM} is time to completion (note: % is the fraction of the amount depleted of D' each interval).

4 reps = 60% depletion of D´, rest 1:1
3 reps = 80% depletion of D´, rest 1:1.5

What happens to CP and W´ after 2h of exercise in the heavy intensity domain?

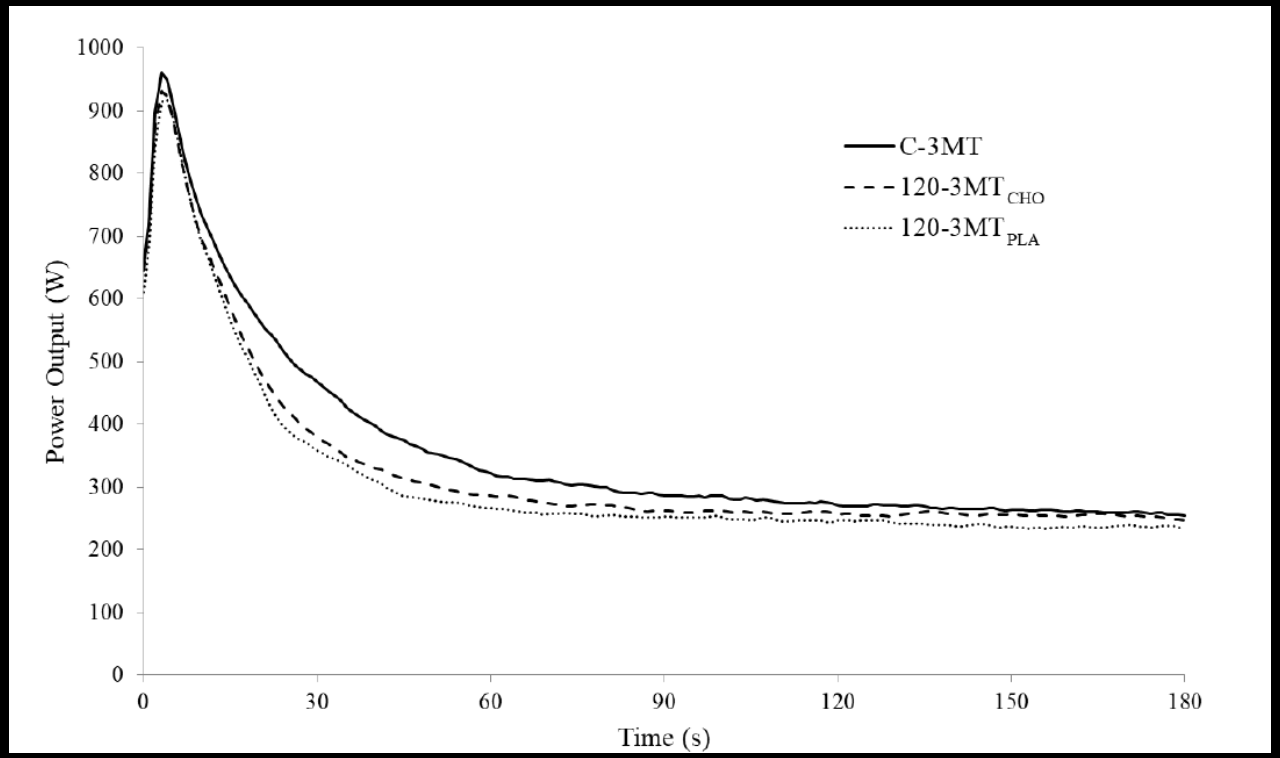


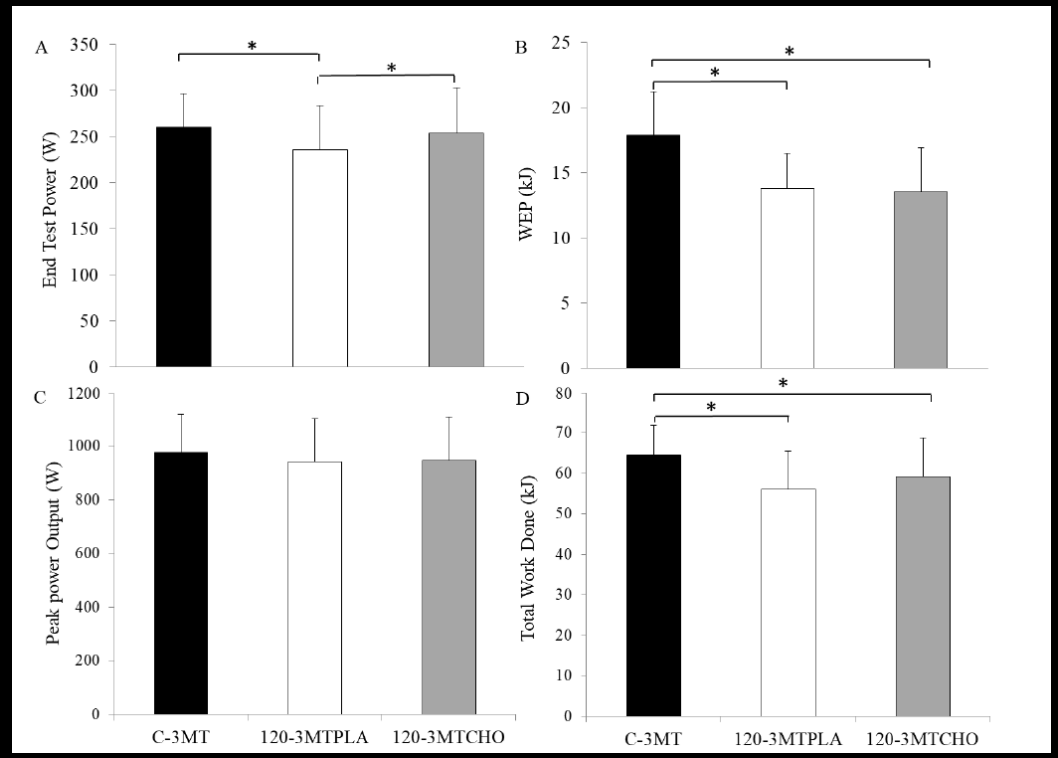


Clark IE, Vanhatalo A, Bailey SJ, Wylie LJ, Kirby BS, Wilkins BW, Jones AM. Effects of 2 hours of heavy-intensity exercise on the power-duration relationship. *Med Sci Sports Exerc* 50: 1658-1668, 2018.

The effects of carbohydrate feeding during exercise

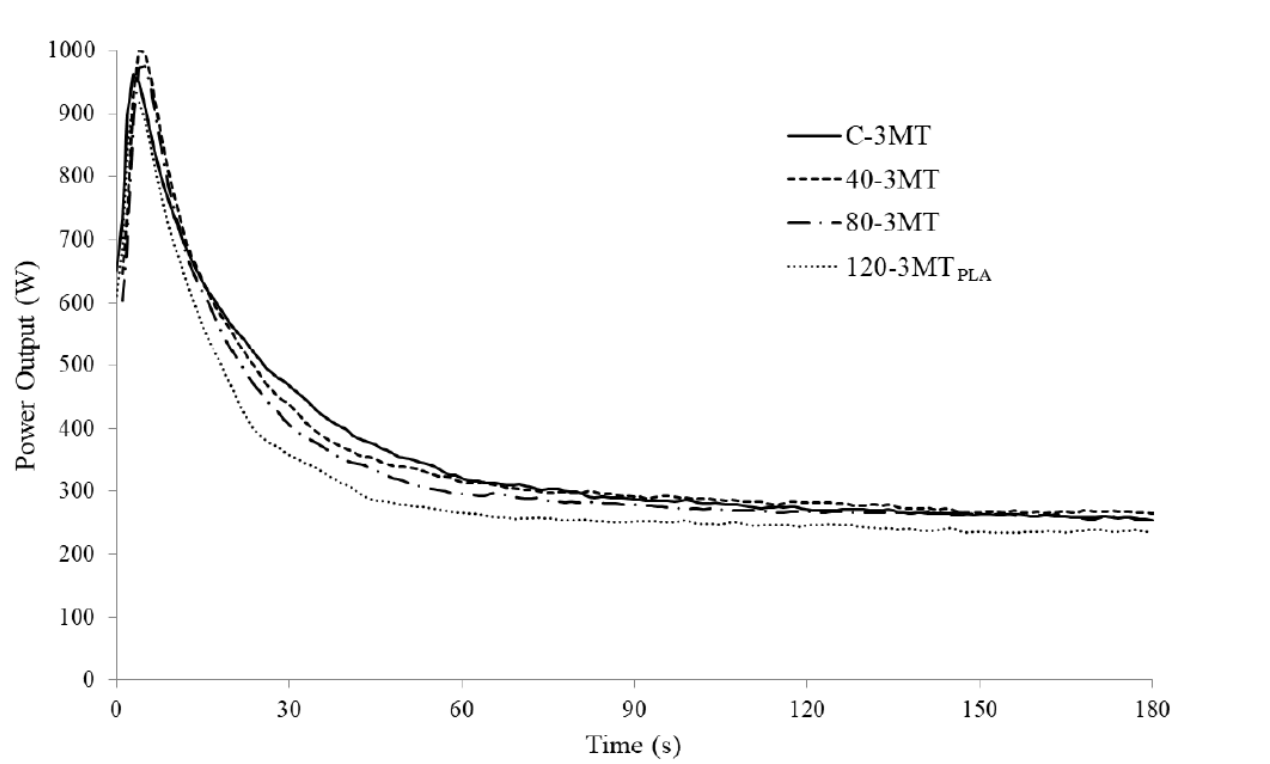
- 60g/h (15g/15min)

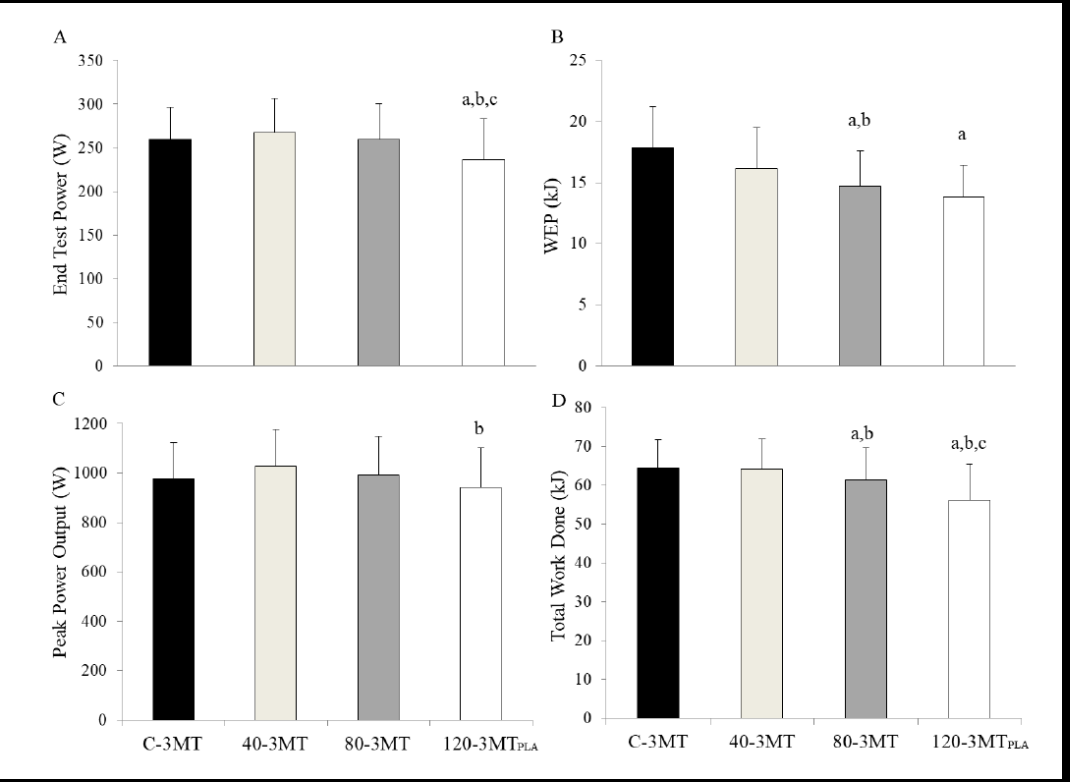




Clark IE, Vanhatalo A, Thompson C, Joseph C, Backwell JR, Wylie LJ, Ten R, Bailey SJ, Wilkins BW, Kirby BS, Jones AM. (2019). Dynamics of the power-duration relationship during prolonged endurance exercise and influence of carbohydrate ingestion. *J Appl Physiol*. 127(3): 726-736

What happens to CP and W´ after 40 and 80min of exercise in the heavy intensity domain?





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