Relationship between skeletal muscle carnosine content and blood bicarbonate concentration and cycling sprint performance

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Applied Physiology & Nutrition
Research Group

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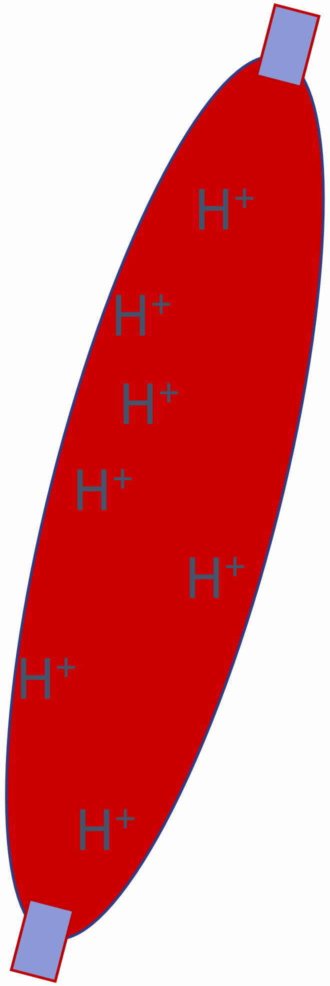
Muscle Fatigue

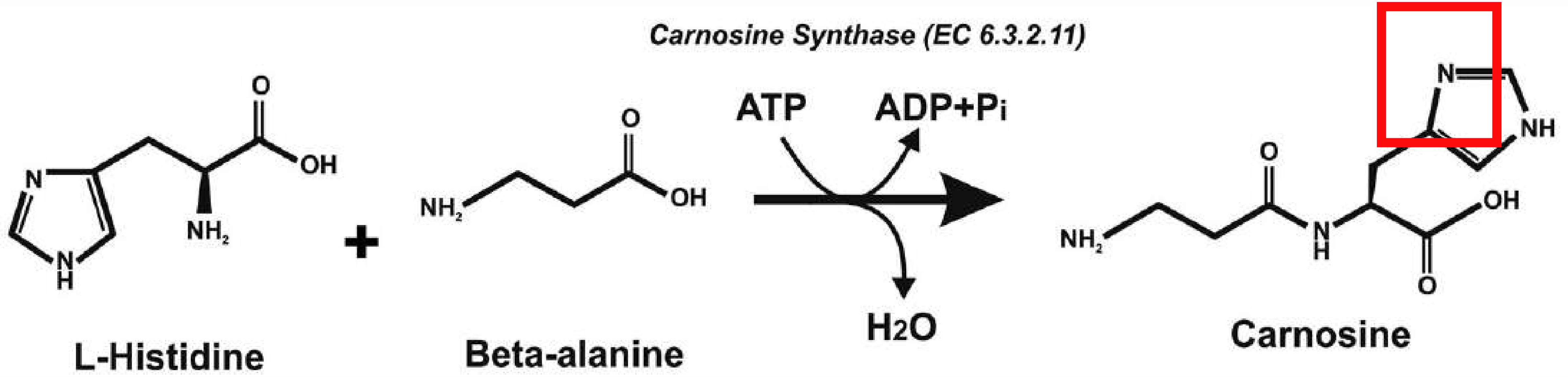
High-intensity exercise



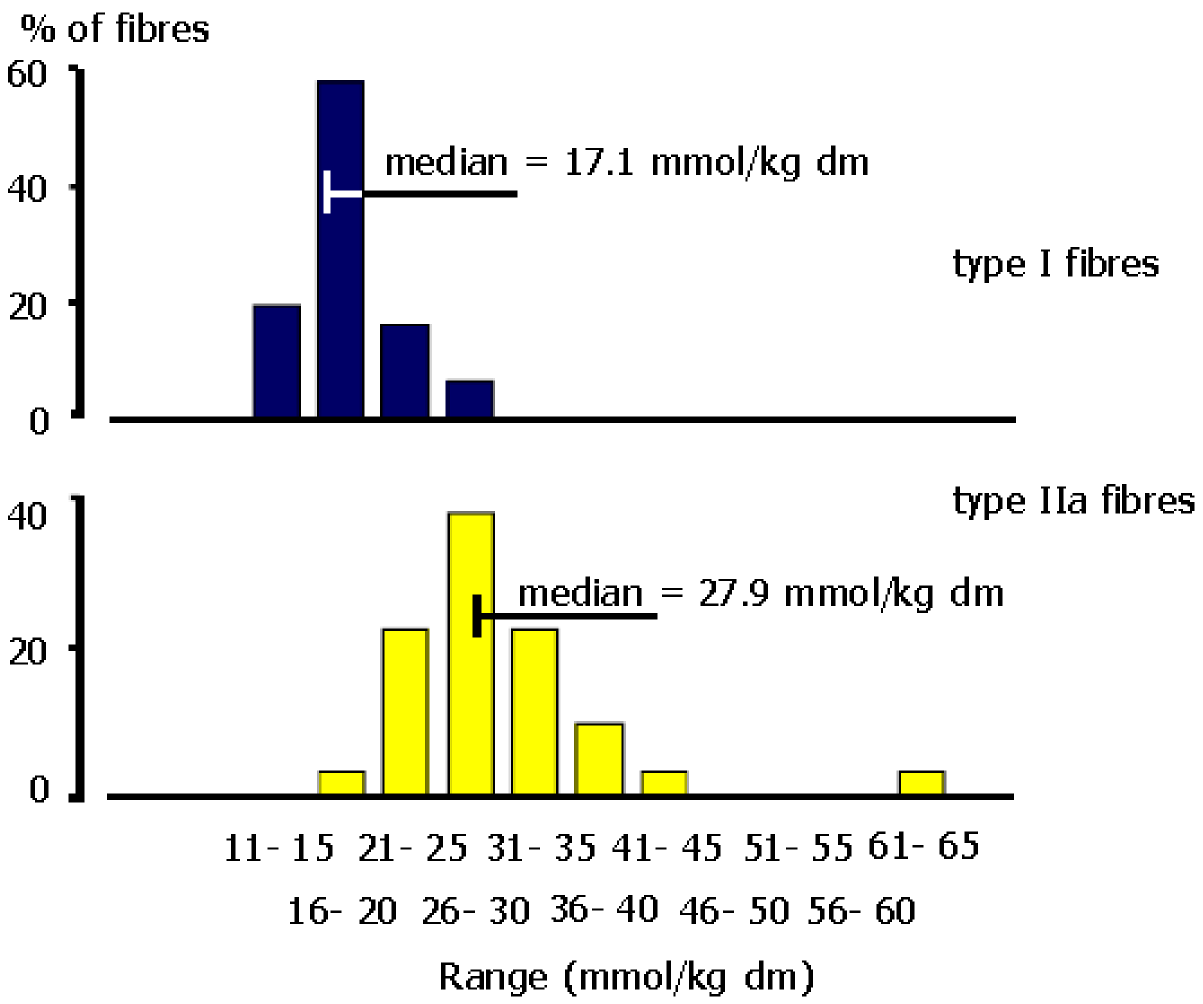
- Decrease intracellular pH;
- Inhibition of key glycolytic enzymes;
- Negatively impact upon resynthesis of phosphorylcreatine
- Damages several stages of the contractile process
- Muscle fatigue

Fitts, 2004

Muscle carnosine



Carnosine distribution in muscle



Harris et al. (2006). Amino Acids, 30(3), 279-289.

Muscle carnosine in different athletes

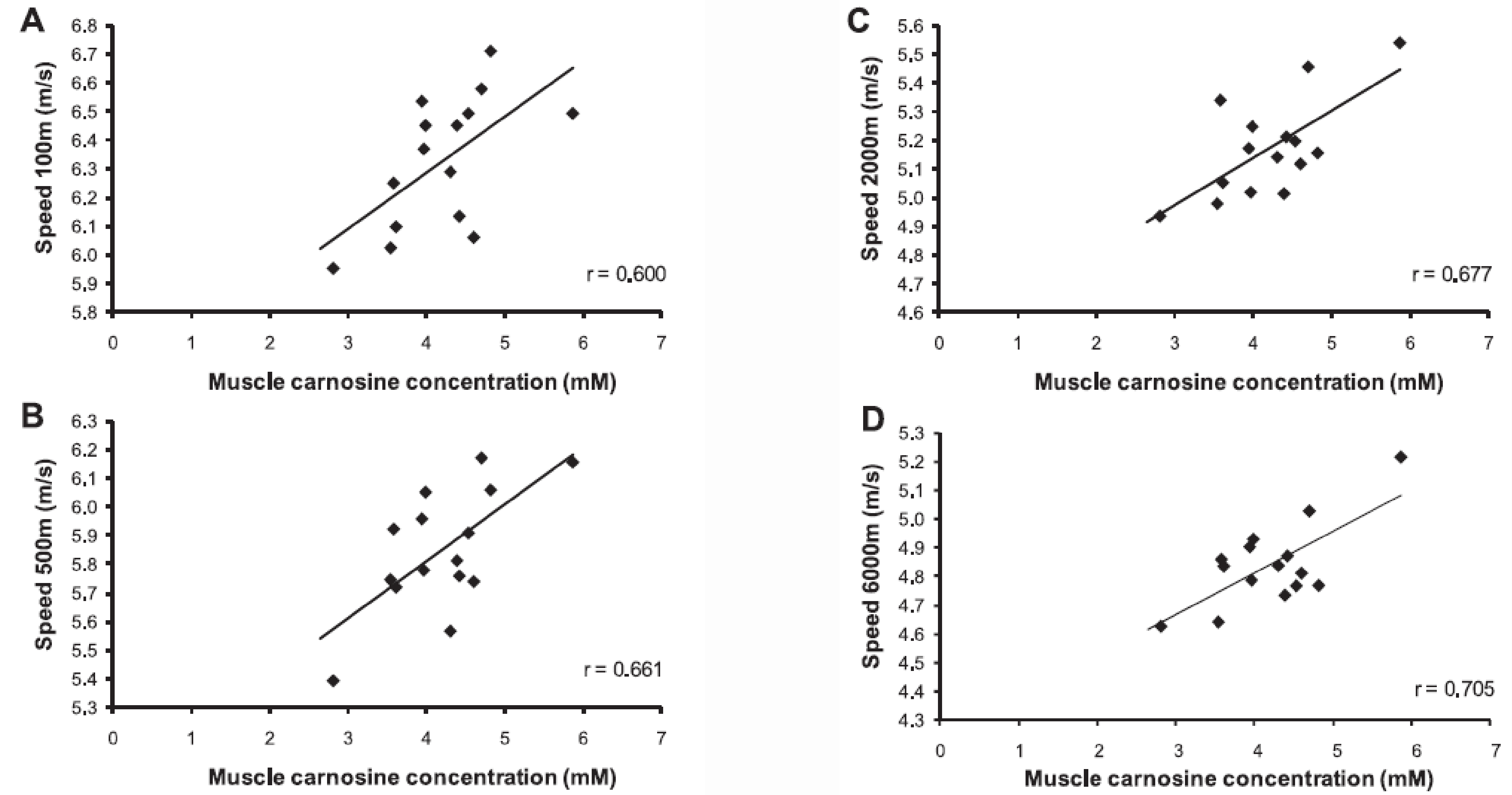
TABLE 2. *Histochemical and biochemical profiles*

Group	Fast-Twitch Percentage, %	Buffer Capacity, $\mu mol \cdot g^{-1} \cdot pH^{-1}$	Histidine Levels, $\mu mol \cdot g^{-1}$	Carnosine Levels, $\mu mol \cdot g^{-1}$
Sprinters	56.6 ±7.0	30.03 ±5.6*	0.64 ±0.06	4.93 ±0.76*
Rowers	50.4 ±12.3	31.74 ±7.2*	0.71 ±0.10	5.04 ±0.72*
Marathoners	33.0 ±12.2	20.83 ±4.4	0.63 ±0.14	2.80 ±0.74
Untrained	50.6 ±9.9	21.25 ±5.0	0.89 ±0.29	3.75 ±0.86

Values are means ± SD. * $P < 0.01$ significantly > marathoners and untrained.

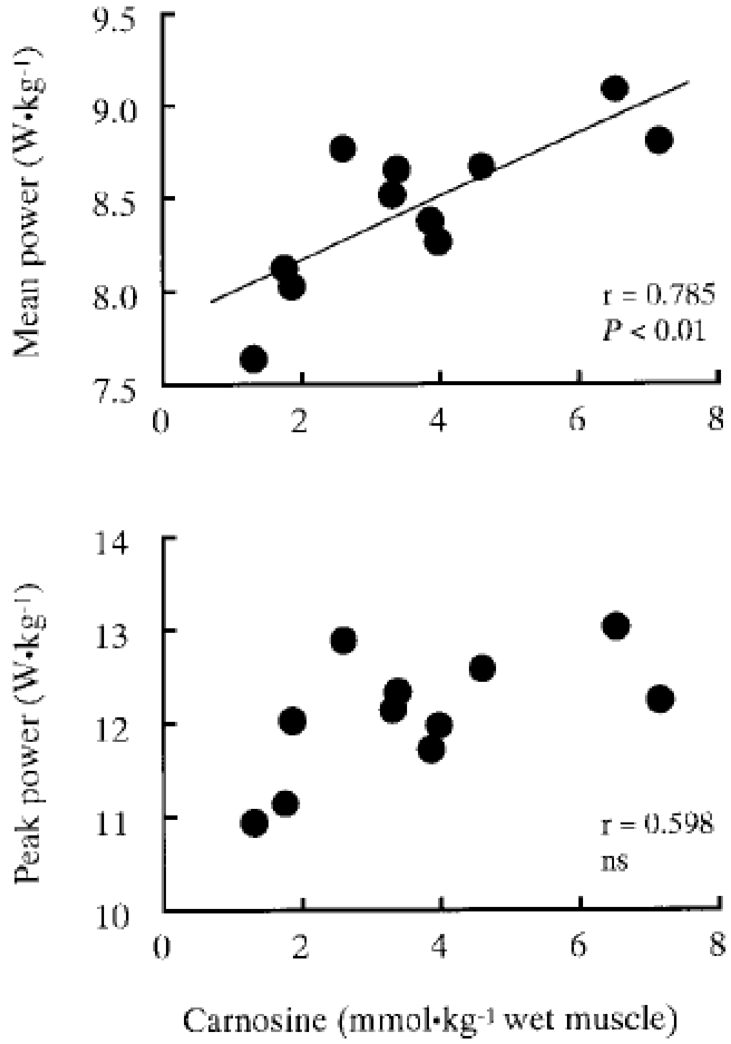
Parkhouse et al. (1985). J Appl Physiol, 58(1), 14-17.

Muscle carnosine and rowing



Baguet et al. (2009). J Appl Pysiol, 109, 1096-1101.

Muscle carnosine and sprint cycling



Suzuki et al. (2002). Jap J Physiol, 52: 199-205.

Repeated sprint ability

Table 2. Correlation coefficients between repeated-sprint ability test scores (RSA_{best}, RSA_{mean}, and RSA_{dec}) and physiological responses to high-intensity, intermittent test and cardiorespiratory measurements ($N = 23$).

	$HIT_{[H^+]}$ (mmol·L^{-1})	$HIT_{[HCO_3^-]}$ (mmol·L^{-1})	$HIT_{[La^-]}$ (mmol·L^{-1})	$\dot{V}O_{2\,max}$ (mL·kg^{-1}·min^{-1})	τ_1 (s)
Correlation coefficients					
RSA_{best} (s)	0.01 (–0.34 to 0.36)	0.12 (–0.24 to 0.45)	0.03 (–0.33 to 0.38)	0.09 (–0.27 to 0.43)	0.14 (–0.22 to 0.47)
RSA_{mean} (s)	0.61* (0.33 to 0.79)	–0.71* (0.48 to 0.85)	0.66* (0.40 to 0.82)	–0.45* (–0.12 to –0.69)	0.62* (0.34 to 0.80)
RSA_{dec} (%)	0.73* (0.51 to 0.86)	–0.75* (–0.54 to –0.87)	0.77* (0.57 to 0.88)	–0.65* (–0.39 to –0.82)	0.62* (0.34 to 0.80)
Semipartial correlations					
RSA_{dec} (%)	0.77* (0.57 to 0.88)	–0.83* (–0.68 to –0.91)	0.81* (0.64 to 0.90)	–0.66* (–0.40 to –0.82)	0.70* (0.46 to 0.84)

Note: Semipartial correlations using best sprint time in the repeated-sprint ability test as a controlled variable between repeated-sprint ability percent decrement and physiological responses during the high-intensity, intermittent test and cardiorespiratory measurements ($N = 23$). HIT, high-intensity, intermittent test; $[H^+]$, blood hydrogen ion concentration; HCO_3^-, blood bicarbonate concentration; $[La^-]$, blood lactate concentration; $\dot{V}O_{2\,max}$, maximal oxygen uptake; τ_1, time constant; RSA, repeated-sprint ability; dec, decrement.

*$p < 0.05$.

Rampinini et al. (2009). Appl Physiol Nutr Metab, 34: 1048-1054.

Sodium bicarbonate supplementation

↑ HCO_3^- HCO_3^- HCO_3^- HCO_3^- HCO_3^- HCO_3^-

↓Muscle Acidosis

↑ Resynthesis of phosphorylcreatine

↑ Glycolysis

↑ Blood lactate

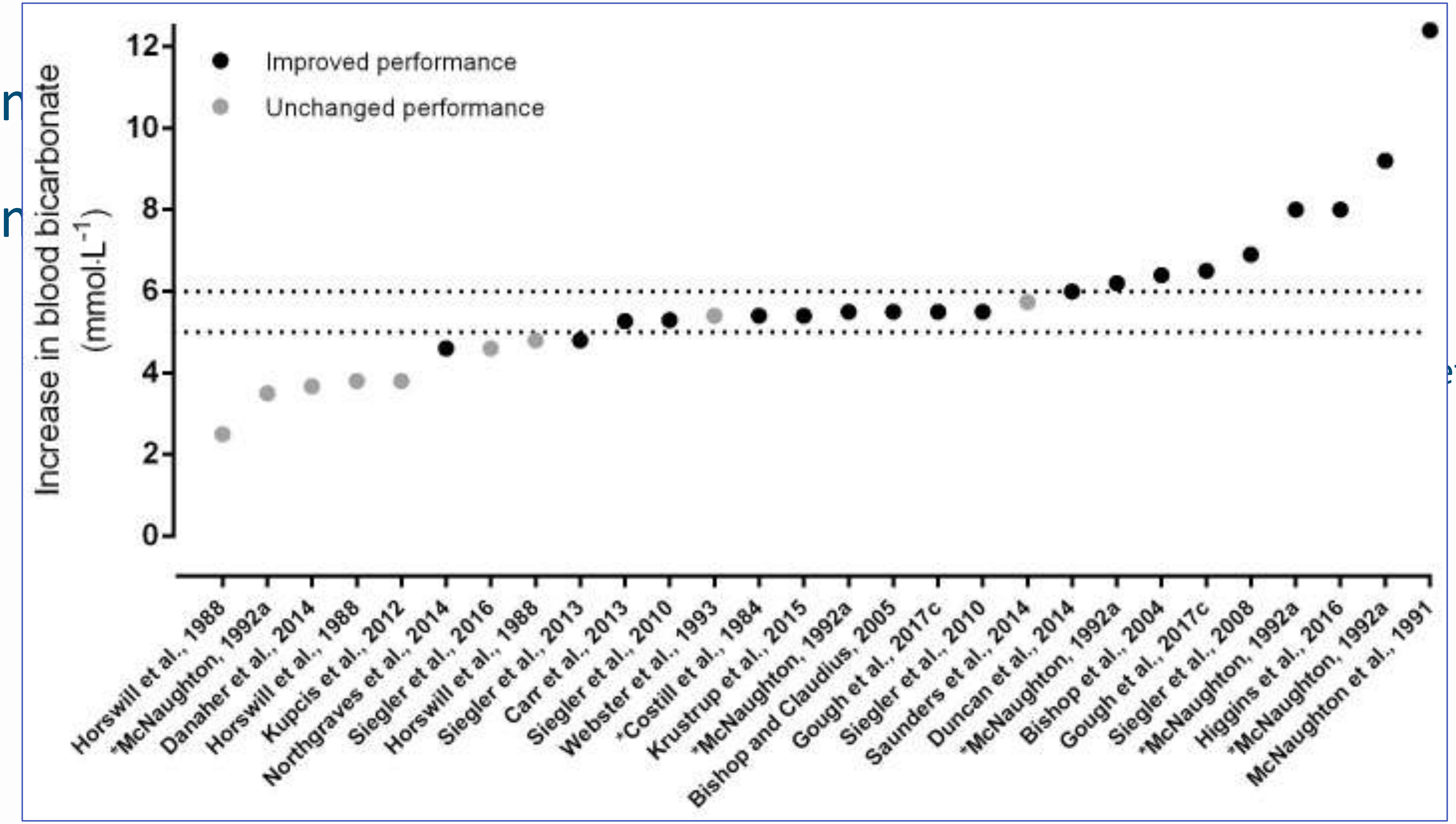
Improve performance

Blood bicarbonate increases and performance

› +5 mm

› +6 mm

et al., 2011)



Heibel et al. (2018). *Frontiers in Nutrition*, 5:35.

Aim

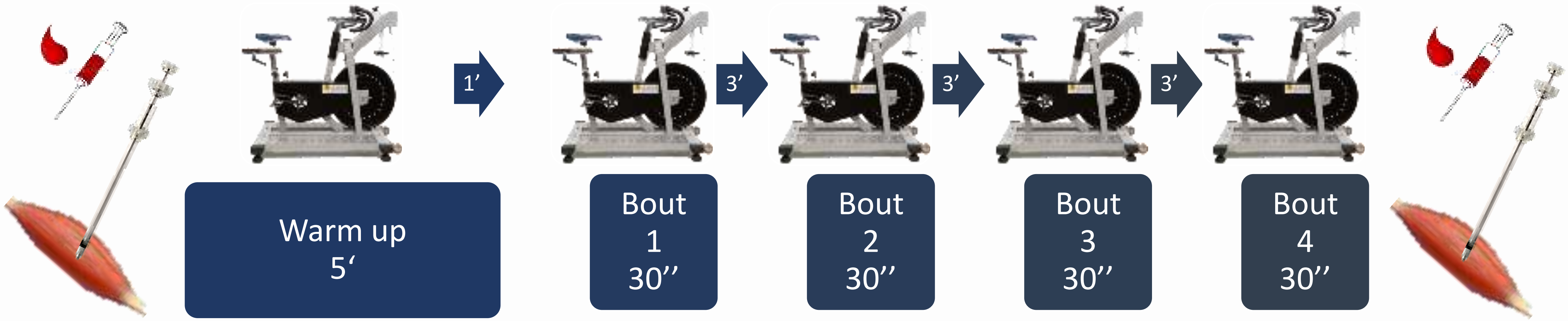
To determine the relationship between blood bicarbonate and muscle carnosine of trained cyclists and high-intensity performance during the 4-bout Wingate cycling test.

Methods

n=41 men cyclists

age: 35 ± 7 y; weight: 74.7 ± 10.5 kg; height: 1.78 ± 0.08 m;

experience: 9 ± 8 years; training hours: 12 ± 6 hours·week^{-1}; training distance: 261 ± 165 km·week^{-1}

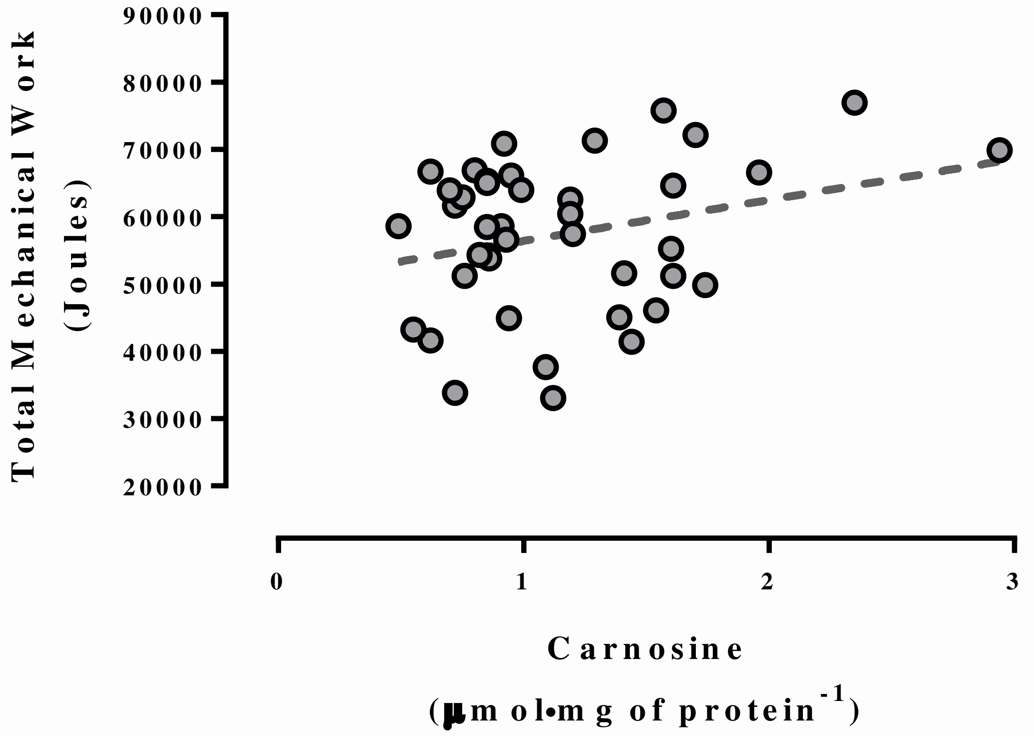


Analisys

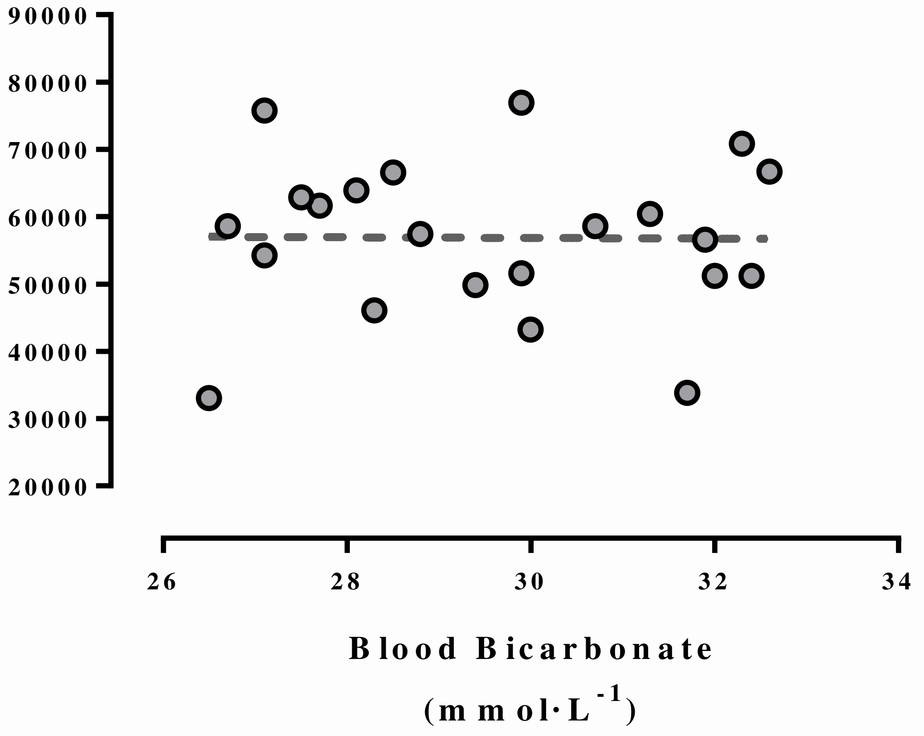
Blood gas analyser (Rapid Point 350)

Liquid chromatography-mass spectrometry (HPLC-ESI$^+$-MS/MS)

Results – correlations

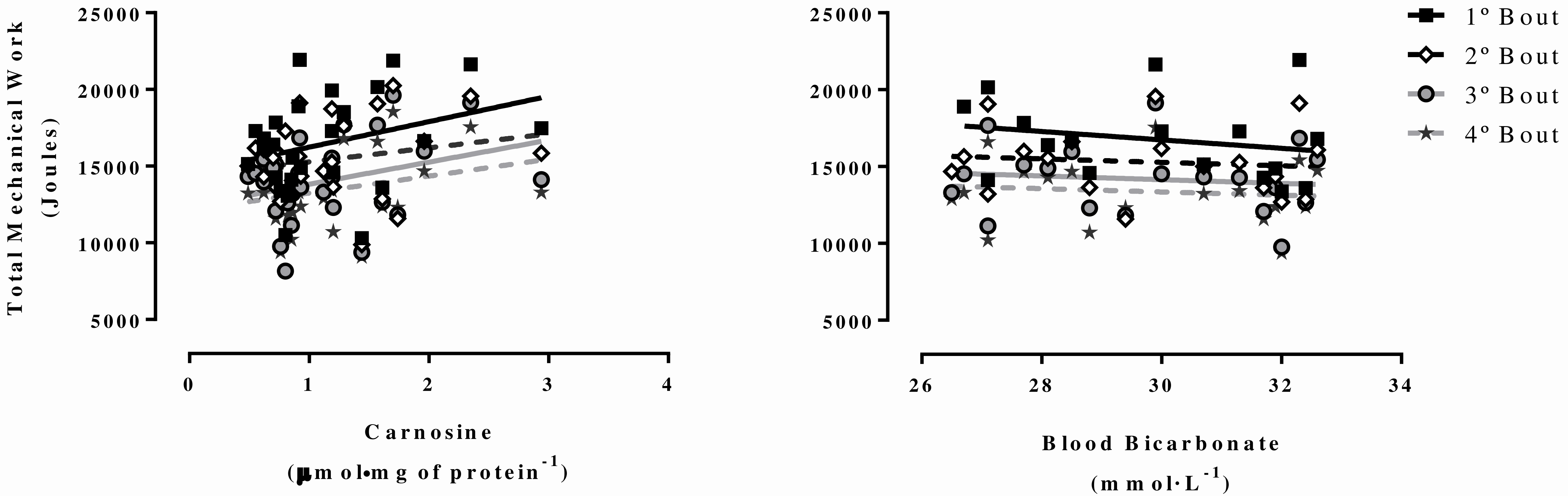


R = 0.28; *p* = 0.08



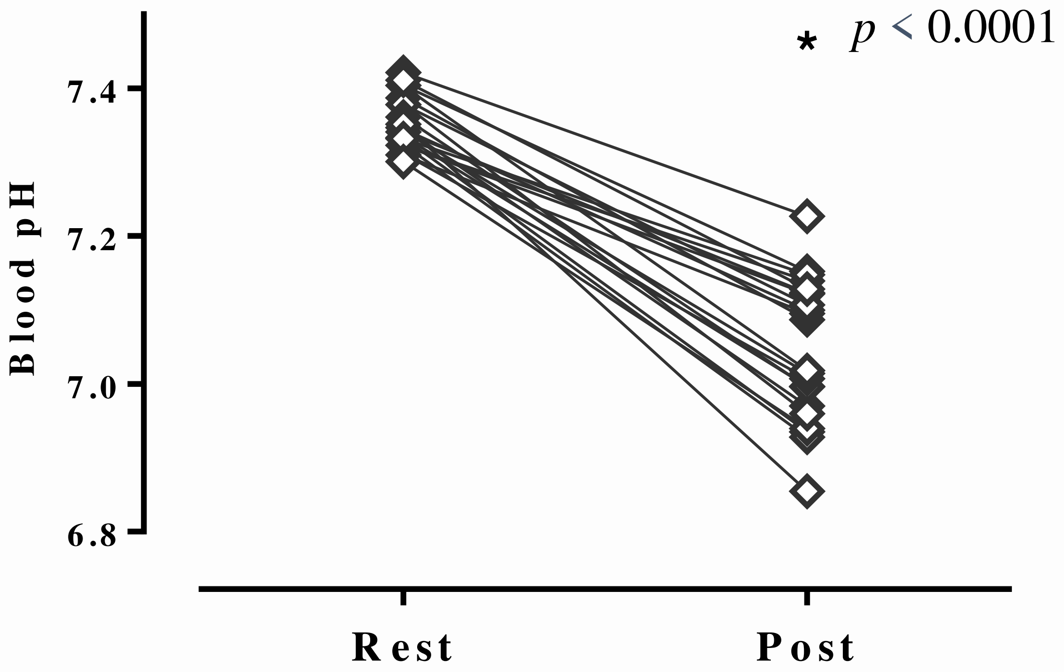
R = 0.01; *p* = 0.97

Results – correlations

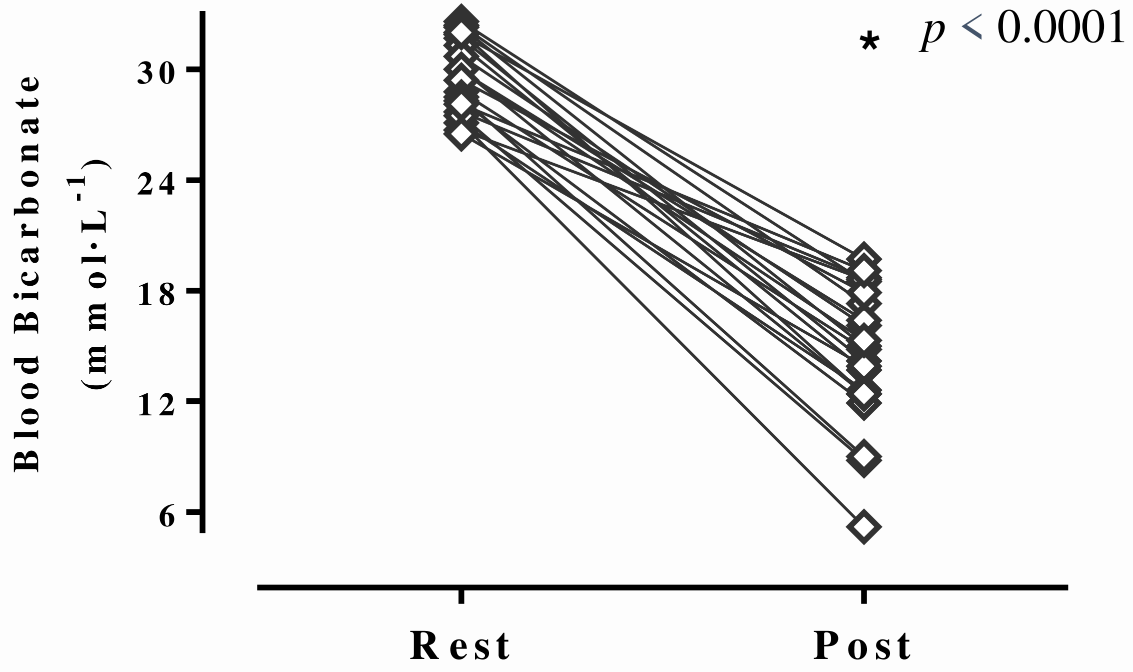


all $p > 0.05$

Results – Blood measures



7.353 ± 0.035   7.048 ± 0.094



29.6 ± 2.1   14.6 ± 3.7

Discussion

Amino Acids (2014) 46:1207–1215
DOI 10.1007/s00726-014-1678-2

ORIGINAL ARTICLE

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TEMPERATURE
2018, VOL. 5, NO. 4, 343–347
https://doi.org/10.1080/23328940.2018.1436393

PRIORITY REPORT

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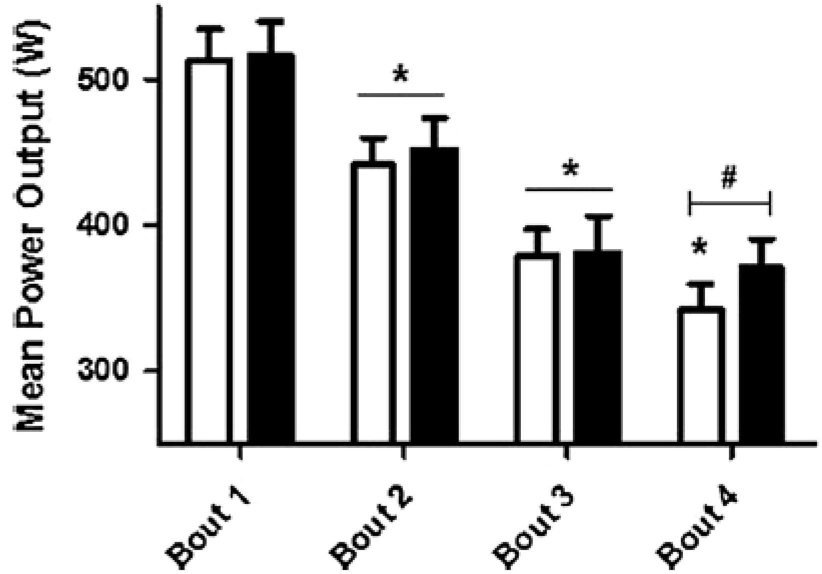

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Table 2. Mean ± SD values (n = 10) for measures of peak power, rate of fatigue and work completed for placebo (NaCl) and treatment ($NaHCO_3$).

	NaCl		$NaHCO_3$	
	WAnT 1	WAnT 2	WAnT 1	WAnT 2
Peak Power (W)	744 ± 141	680 ± 125*	731 ± 128	715 ± 114
Rate of Fatigue (%)	34 ± 7	32 ± 14	35 ± 9	34 ± 10
Work Completed (kJ)	18.5 ± 2.8	16.4 ± 2.3*	18.4 ± 2.4	17.2 ± 2.1†

Footnotes: Measures during first (WAnT 1) and second (WAnT 2) Wingate anaerobic tests. *Significant difference to corresponding WAnT 1 value; †Significant difference to corresponding NaCl value

Conclusions

- This study showed no association between repeated sprint cycling performance and blood bicarbonate or muscle carnosine;
- Sodium bicarbonate and beta-alanine supplementation have previously been shown to improve repeated Wingate performance, particularly in the final bouts;
- Since fatigue during high-intensity activity is multifactorial, this may indicate that small baseline variations in blood bicarbonate and muscle carnosine are not large enough to translate into performance benefits;
- It is likely that supplementation with sodium bicarbonate and beta-alanine result in changes of sufficient magnitude to delay fatigue and improve performance.

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Thank you!

Dank je wel!
Merci!
Obrigada!