POTENTIATION OF SPRINT CYCLING PERFORMANCE:
The Effects of a High-Inertia Ergometer Warm-Up

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Abstract

Assimilating current knowledge in the field of acute post-activation potentiation (PAP) of athletic performance, this study attempted to ensure optimal conditions for performance gain, by utilising highly-trained sprint-athletes, a biomechanically similar conditioning activity and following recommendations for the most appropriate conditioning protocol. Employing a randomized, counterbalanced, cross-over design with repeated measures, 4 male and 2 female national and international competitive sprint cyclists (age 19.2 $\pm$ 3.2 years; height 175.2 $\pm$ 7.0 cm; body mass 75.5 $\pm$ 9.8 Kg; training years (sprint cycling) 4.0 $\pm$ 1.5 years; training years (strength) 3.5 $\pm$ 1.2 years; peak isometric pedal torque 255.85 $\pm$ 37.75 Nm) executed multiple sets of short maximal contractions on a custom-built high-inertia ergometer as a potentiating stimulus prior to sprint cycle performance. Three trial conditions were completed on three separate days: a standardised warm-up followed by either dynamic (DYN: 4 x 4 complete crank cycles), or isometric (ISO: 4 x 5-second MVC) conditioning contractions (CC), or a control condition (CON) where subjects actively rested for the total equivalent time post-warm-up. Performance was assessed in a short (~6 seconds) maximal acceleration from standing start to maximum velocity on an inertial-load ergometer at baseline (Pre), 4 (Post4), 8 (Post8) and 16 (Post16) minutes following the CC protocol. Torque-cadence and power-cadence relationships were derived from crank data recorded throughout the sprint. Performance time and peak and average biomechanical measures were assessed over 4 discrete sprint segments. Outcomes were assessed using 2-way repeated measures ANOVA and magnitude-bases inferences. DYN Post4 was the only trial improving performance time, affecting a 3.91 ± 3.74% (92% likelihood of exceeding smallest worthwhile change (SWC)) decrease in time over the first segment of the sprint such that overall performance time was substantially improved. Biomechanical improvements in this trial were predominantly on the ascending limb of the power-cadence relationship, affecting an increase of 6.24 ± 5.95% in peak torque (94% likelihood of exceeding SWC) and 4.04 ± 6.52% (87% likelihood of exceeding SWC) in average power during initial acceleration. Conversely, ISO Post16 enhanced performance over the descending limb of the power-cadence relationship, affecting an increase in optimal cadence (~3.1% increase when compared to change from baseline in control condition, 82% likelihood of exceeding SWC) and augmenting average power (~5% improvement when compared to change from baseline in control condition, 76% likelihood of exceeding SWC) during the maximal velocity phase of the sprint. DYN Post16 affected only small improvements at either extremity of the relationship, while few changes were observed in the remaining trial conditions. Results imply that each trial-time combination presented distinct performance conditions characterised by the predominance of different PAP mechanisms. This study provisionally suggests the efficacy of a including a high-inertia ergometer component in the sprint warm-up. Improvements at the functional extremities of the sprint would benefit starting acceleration or finishing speed, where compromise in gear and pedal length selection strategies would, otherwise, impose limitations on performance.

Keywords: post-activation potentiation, sprint cycling, neuromuscular performance, warm-up

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ADP	adenosine diphosphate
ATP	adenosine triphosphate
BP	bench press
BPT	bench press throw
BS	back squat
Ca^{2+}	calcium ion
CC	conditioning contractions
CMJ	counter movement jump
DJ	drop jump
ECC	excitation-contraction coupling
EMD	electromechanical delay
EMG	electromyography
EPSP	excitatory post-synaptic potentials
ES	effect size
F_0	peak isometric force
FVP	force-velocity-power
GTO	golgi-tendon organ
H-reflex	Hoffman reflex
HC	hang cleans
HFF	high-frequency fatigue
JS	jump squat

LFF	low-frequency fatigue
MA	musculoarticular
MB	medicine ball
MF	metabolic fatigue
MGL	gastrocnemius
MHC	myosin heavy chain
MLCK	myosin light chain kinase
MRLC	myosin regulatory light chains
MTU	muscle-tendon unit
MU	motor unit
MVC	maximal voluntary contraction
NMF	non-metabolic fatigue
PAD	post-activation depression
PAP	post-activation potentiation
pCa^{2+}	plasma ionized calcium
PS	power snatch
PTA	peak torque angle
PTP	post-tetanic potentiation
RFD	rate of force development
RM	repetition maximum
RP	reflex potentiation
SEC	series elastic components
SJ	squat jump
SOL	soleus

SSC	stretch shortening cycle
SWC	smallest worthwhile change
TDC	top dead centre
TJ	tuck jump
TP	twitch potentiation
TT	twitch torque
V_0	maximum unloaded shortening velocity
VJ	vertical jump
VO_2	oxygen consumption
VO_{2max}	maximal oxygen consumption