International Journal of Sports Physiology and Performance, 2012, 7, 186-188

Warm-Up Intensity and Duration's Effect on Traditional Rowing Time-Trial Performance

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The warm-up procedure in traditional rowing usually involves continuous low-intensity rowing and short bouts of intense exercise, lasting about 60 min. ***Purpose:*** To compare the effects of a traditional and an experimental 30-min warm-up of lower intensity on indoor rowing time-trial performance. ***Methods:*** Fourteen highly trained male rowers (age 25.9 ± 5.3 y, height 1.86 ± 0.06 m, mass 80.4 ± 5.2 kg, peak aerobic power 352.0 ± 24.4 W; mean ± SD) performed 2 indoor rowing trials 12 d apart. Rowers were randomly assigned to either LONG or SHORT warm-ups using a crossover design, each followed by a 10-min all-out fixed-seat rowing-ergometer time trial. ***Results:*** Mean power output during the time trial was substantially higher after SHORT (322 ± 18 vs 316 ± 17 W), with rowers generating substantially more power in the initial 7.5 min of the time trial after SHORT. LONG elicited substantially higher mean warm-up heart rate than SHORT (134 ± 11 vs 121 ± 13 beats/min), higher pre–time-trial rating of perceived exertion (10.2 ± 1.4 vs 7.6 ± 1.7) and blood lactate (1.7 ± 0.4 mM vs 1.2 ± 0.2 mM), but similar heart rate (100 ± 14 vs 102 ± 9 beats/min). No substantial differences were observed between LONG and SHORT in stroke rate (39.4 ± 2.0 vs 39.4 ± 2.2 strokes/min) or mean heart rate (171 ± 6 vs 171 ± 8 beats/min) during the time trial, nor in blood lactate after it (11.8 ± 2.5 vs 12.1 ± 2.0 mM). ***Conclusion:*** A warm-up characterized by lower intensity and shorter duration should elicit less physiological strain and promote substantially higher power production in the initial stages of a rowing time trial.

Keywords: pacing, performance, fatigue, power output

An active warm-up is a routine performed by most athletes to improve competitive performance. This practice purportedly increases muscle temperature, nerve-conduction rate, speed of metabolic reactions, oxygen-uptake kinetics, muscle postactivation potentiation, and psychological preparedness.[1] Despite these potential benefits, most warm-up procedures used by athletes and coaches are based on practical experience and tradition rather than scientific evidence, and little is known about the best warm-up practices for specific sports.[2] In addition, an improperly designed warm-up protocol could induce fatigue and have a negative impact on subsequent athletic performance.[3,4] The purpose of this investigation was to compare the effects of a traditional warm-up and an experimental warm-up of lower intensity and shorter duration on maximal performance in an indoor rowing time trial.

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Methods

Fourteen highly-trained male traditional rowers (age 25.9 ± 5.3 y, height 1.86 ± 0.06 m, mass 80.4 ± 5.2 kg, peak fixed-seat aerobic power 352.0 ± 24.4 W; mean ± SD) performed 2 indoor rowing trials separated by 12 days (ambient temperature 24.1°C ± 0.9°C, relative humidity 54.7% ± 2.1%). Training load was reduced and identical for all subjects the day before each testing session. Each trial consisted of either a traditional 60-minute warm-up (LONG) or an experimental warm-up characterized by lower intensity and 30 minutes duration (SHORT), followed by a 10-minute all-out fixed-seat indoor rowing time trial (TT). Subjects were familiar with rowing trials performed on a wind-braked rowing ergometer (Concept 2, Model D, Morrisville, VT) modified with a static seat, legs in semiflexion at a length adapted to each rower, and a drag factor of 145. They were randomly assigned to LONG or SHORT warm-up, using a crossover design. Both warm-up procedures are described in detail in Table 1. Heart rate was continuously monitored (Suunto Team Pack Pro, Vantaa, Finland) throughout the warm-up and TT, rating of perceived exertion was recorded immediately before the TT, and blood lactate was measured from a 5-µL capillary blood sample obtained from an ear lobe (Lactate Pro, Arkray Factory Inc, Shiga, Japan)

immediately after the warm-up, immediately before the TT, and after finishing the TT.

Descriptive statistics are mean ± SD. Rowing performance and physiological measures were analyzed in a post-only crossover design.[5] Data were log-transformed to reduce the nonuniformity of error and then back-transformed to obtain the percentage difference in the means between the treatment conditions. Precision of estimation was indicated with 90% confidence limits. Magnitude of the difference between conditions was interpreted using a Cohen effect statistic where <0.2 is trivial, 0.2 to 0.6 is small, 0.6 to 1.2 is moderate, 1.2 to 2.0 is large, and >2.0 is very large. An effect was inferred to be unclear if its confidence interval spanned substantial positive and substantial negative values.

Results

Mean power output during the TT was substantially higher (2.1% ± 1.3%, mean ± 90% confidence limits) after SHORT, with rowers generating more power in the initial 7.5 minutes of the TT after SHORT. LONG elicited substantially higher mean heart rate during the warm-up than SHORT, as well as higher rating of perceived exertion and blood lactate immediately before the TT, but similar heart rate. No substantial differences were observed between LONG and SHORT in power output during the final 2.5 minutes of the TT, in stroke rate and mean heart rate during the 10-minute TT, or in blood lactate concentration at the end of the trial (Table 2).

Table 1 Traditional (LONG) and Experimental (SHORT) Warm-Up Protocols

LONG	SHORT
20-min continuous row (<2 mM power output)	10-min continuous row (<2 mM power output)
5-min passive recovery	5-min passive recovery
10-min continuous row (<2 mM power output)	2 × (20 progressive strokes: from <2 mM power output to peak aerobic power/2-min recovery row)
4 × (20 progressive strokes: from <2 mM power output to peak aerobic power/2-min recovery row)	10-min passive recovery
5-min passive recovery	*Start time trial*
Race start simulation: 3 quick strokes + 10 maximal strokes	
5-min passive recovery	
Start time trial	
Total duration ≈ 60 min	Total duration ≈ 30 min

Table 2 Physiological and Performance Measures Elicited by Traditional (LONG) and Experimental (SHORT) Warm-Up Protocols

Measure	LONG (mean ± SD)	SHORT (mean ± SD)	% Difference (90% CL)	Effect size (90% CL)	Qualitative inference
Mean warm-up HR (beats/min)	134 ± 11	121 ± 13	–12.5 ± 3.2	–1.18 ± 0.32	moderate
Post-warm-up La (mM)	2.0 ± 0.3	2.0 ± 0.4	1.9 ± 9.4	0.09 ± 0.43	unclear
Pre-TT HR (beats/min)	100 ± 14	102 ± 9	1.8 ± 4.9	0.15 ± 0.38	unclear
Pre-TT La (mM)	1.7 ± 0.4	1.2 ± 0.2	–29 ± 9	–1.46 ± 0.39	large
Pre-TT RPE	10.2 ± 1.4	7.6 ± 1.7	–26 ± 10	–1.55 ± 0.47	large
TT 1st-quarter power (W)	334 ± 24	349 ± 24	4.4 ± 2.1	0.58 ± 0.28	small
TT 2nd-quarter power (W)	304 ± 18	314 ± 18	3.1 ± 1.9	0.50 ± 0.31	small
TT 3rd-quarter power (W)	305 ± 22	311 ± 18	2.1 ± 1.8	0.30 ± 0.26	small
TT 4th-quarter power (W)	320 ± 20	318 ± 20	–0.5 ± 2.9	–0.08 ± 0.43	unclear
Mean TT power (W)	316 ± 17	322 ± 18	2.1 ± 1.3	0.36 ± 0.22	small
Mean TT stroke rate (strokes/min)	39.4 ± 2.0	39.4 ± 2.2	0.1 ± 1.8	0.03 ± 0.31	unclear
Mean TT HR (beats/min)	171 ± 6	171 ± 8	0.1 ± 0.9	0.03 ± 0.20	trivial
TT HR_{max} (beats/min)	183 ± 9	183 ± 9	0.0 ± 0.6	0.01 ± 0.11	trivial
Post-TT La (mM)	11.8 ± 2.5	12.1 ± 2.0	3.5 ± 11.3	–0.16 ± 0.50	unclear

Abbreviations: CL, confidence limits; HR, heart rate; La, blood lactate concentration; TT, time trial; RPE, rating of perceived exertion.

Effect size: trivial < 0.2, small 0.2–0.6, moderate 0.6–1.2, large 1.2–2.0, very large > 2.0. An effect was inferred to be unclear if its confidence interval spanned substantial positive and substantial negative values.

Discussion

Excessively intense and long warm-up routines have been shown to induce fatigue and impair subsequent running and cycling performance of various durations.[3,4] In the current investigation, the less intense and shorter experimental warm-up protocol had a substantial beneficial effect on physiological and performance measures in comparison with the traditional warm-up usually implemented by this group of rowers. A mean improvement in power of ~2% should have a substantial effect on rowing performance.[6] Higher mean heart rate and pre–time-trial blood lactate and rating of perceived exertion are indicative of increased physiological strain during the traditional LONG warm-up. This outcome is in keeping with studies indicating that the warm-up may promote a reduction in prolonged submaximal endurance performance through mechanisms associated with the earlier development of high internal body temperature, negatively affecting the capacity for heat storage even in moderate environmental temperatures.[3]

The rowing trials in this study were conducted in relatively mild environmental conditions, but the observed detrimental effects of the LONG warm-up could be exacerbated in the hotter and more humid conditions often experienced during summer training and competition. In agreement with a previous report on highly trained track cyclists, the change in blood lactate concentration during the TT was somewhat greater after the SHORT warm-up, suggesting a greater anaerobic contribution to power production in the early stages of the TT after SHORT.[4] In conclusion, a warm-up characterized by lower intensity and shorter duration should elicit less physiological strain and promote substantially higher power production in the initial stages of a rowing TT. We encourage coaches and rowers to experiment with shorter, lower-intensity warm-up regimens.

Acknowledgments

The authors would like to thank the rowers and coaching staff of Orio Arraunketa Elkartea for their enthusiasm and cooperation throughout the study.

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