

Effects of pacing strategy on performance and physiological responses in a simulated 1000-m kayak race under the new Olympic schedule

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Purpose: This study examined whether adding an all-out start (AO) to a self-paced strategy increased average power output as a measure of performance in a fixed-duration 4-min kayak ergometer trial simulating a 1000-m kayak race under the new Olympic canoe sprint schedule, and whether this pacing modification altered physiological responses.

Methods: Nine national-level male kayakers completed three 4-min kayak-ergometer trials over two consecutive days: a self-paced (SP) trial on day 1, and even-paced (EP) and AO trials on day 2 separated by 2 hours to simulate semifinal and final, respectively. In EP, athletes matched the average power output (PO) from SP; in AO, they performed a 15-s maximal effort followed by self-paced paddling. Mechanical and physiological variables, including PO, stroke rate, oxygen uptake, heart rate (HR), blood lactate, and acid-base parameters, were measured. Data were analyzed with frequentist and Bayesian repeated-measures ANOVA.

Results: Compared with SP, AO produced higher average PO (194 ± 14 vs 185 ± 22 W; $P = .027$; $BF_{10} = 1.82$) and peak HR (195 ± 4 vs 192 ± 3 beats/min; $P = .045$; $BF_{10} = 4.22$), although the HR difference lay within typical day-to-day variability. The remaining physiological variables did not differ between strategies (all $P > .35$), with Bayes factors ($BF_{10} = 0.25$ – 0.43) providing anecdotal to moderate evidence for the null model.

Conclusions: A 15-s all-out start superimposed on a self-paced strategy may increase average power output during a fixed-duration 4-min kayak ergometer trial under the Olympic regatta schedule without increasing physiological strain. This finding supports its use as a pacing option in canoe sprint, although transferability to on-water conditions may be limited by different resistive forces.

Keywords: sport performance, race pace, all-out start, canoe sprint, kayak ergometer.

Introduction

Comprehensive preparation of athletes for competition involves the systematic integration of physical conditioning, technical proficiency, and psychological readiness, complemented by strategic competencies, such as pacing strategies, that are critical to optimizing their physiological potential. Nevertheless, the most effective strategies for achieving this optimization remain to be definitively established.¹

In long-distance races, adopting an appropriate pacing strategy is particularly important. Such a strategy is key to limiting severe depletion of energy reserves, preventing serious fluid and electrolyte imbalances, and reducing excessive increases in core body temperature. These factors have been shown to be associated with a premature decline in performance capacity². A substantial body of research suggests that athletes tend to achieve better performance when they maintain an even pace throughout the race.^{1,3}

Pacing strategy is also important in middle-distance races, in which a substantial reliance on anaerobic metabolism⁴ makes acute acidosis in fast-twitch muscle fibers the principal factor limiting performance⁵. Given the finite energy available from

anaerobic sources, athletes must carefully optimize their use by balancing maximal effort against the need to avoid premature attainment of the fatigue tolerance threshold.^{1,6–8} However, research on pacing strategies in middle-distance events has produced mixed findings: some studies report that an all-out or fast-start approach (i.e., beginning the race at maximal or near-maximal intensity) improves performance,^{9–11} whereas others report no such benefit or even negative consequences.^{12–14}

Furthermore, research on optimizing pacing has largely focused on sports in which performance depends primarily on the lower limbs. Consequently, whether pacing strategies derived from lower-limb-dominant sports generalize to disciplines with distinct biomechanical demands, such as canoe sprint, in which propulsion is generated predominantly by the upper-body musculature, remains unclear. To date, the only study on pacing strategy in canoe sprint identified was conducted by Bishop et al. The researchers employed a 2-min kayak ergometer test specifically designed to simulate the 500-m race distance, as this duration closely matches the typical completion time for well-trained kayakers.¹⁵ The results demonstrated that an all-out start strategy resulted in significantly greater average power output compared to an even-paced strategy. Consequently, the authors

suggested that this higher average power reflects a greater performance potential for 500-m races, although they noted that further research is needed to determine how effectively these ergometer-based improvements translate to actual on-water performance.

At the Olympic Games, however, men compete in single kayaks (K1) over twice this distance (1000 m). Since the benefits of maintaining a relatively even pacing profile become more pronounced as event duration increases,^{1,16} and observations of pacing strategies in real racing conditions show differences between the 500 m and 1000 m events,¹⁷ it remains unclear whether an all-out start is equally advantageous over 1000 m.

Since the Tokyo 2020 Olympic Games, a new competition format has been introduced in canoe sprint events. Under this format, the semifinals and finals take place on the same day, with only approximately two hours of recovery between races. This schedule markedly increases the physiological demands placed on athletes and presents a significant challenge for regulating effort. To the best of our knowledge, no studies have specifically examined the effectiveness of pacing strategies under this competition format, in which athletes compete in both the semifinal and final on the same day with limited recovery time. Therefore, the present study aimed to examine whether adding an all-out start (AO) to a self-paced strategy increased average power output as a measure of performance in a fixed-duration 4-min kayak ergometer trial simulating a 1000-m kayak race under the new Olympic canoe sprint schedule, and whether this pacing modification altered physiological responses. We hypothesized that, compared with a typical self-paced strategy, an all-out start would result in higher average power output during this simulated race.

Methods

Participants

Nine male sprint kayakers who trained and competed regularly at the national level and were classified as Tier 3 athletes,¹⁸ voluntarily participated in this study. Their mean ($\pm$ SD) age, training experience, height, and body mass were 19.1 ± 2.2 years, 6 ± 2 years, 184 ± 5 cm, and 80.3 ± 8.9 kg, respectively. All participants held valid competition licenses and had medical clearance for competitive sport. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local research ethics committee (KEBN-25-114-DS). All participants were fully informed about the study's purpose, procedures, and potential risks before providing written informed consent.

To ensure participant safety and identify any contraindications to maximal-intensity exercise, all participants underwent additional medical examinations before the experimental phase. These examinations were conducted by a physician and included a review of medical history, a resting electrocardiogram, blood pressure measurement, and auscultation of the heart and lungs. All experimental sessions were conducted under the direct supervision of a physician and a registered nurse.

Study design

The study employed a within-subject experimental design, conducted over two consecutive days. Participants completed three 4-min trials on a kayak ergometer, differing in pacing strategy. The primary outcome measure was power output during each trial, along with selected physiological indicators, allowing comparison of performance across different pacing strategies within the same athletes.

Methodology

Over two consecutive days, between 10:00 a.m. and 1:00 p.m., participants completed three fixed-duration 4-min trials on a commercially available kayak ergometer (Dansprint ApS, Hvidovre, Denmark), each simulating the physiological demands of a 1000-m kayak race. Because the athletes' clubs had similar ergometers, all participants were familiar with the equipment before testing.

On the first day, athletes performed a single 4-min maximal trial using their typical self-paced (SP) strategy for a 1000-m race. This trial was conducted as part of the clubs' performance assessment in a highly competitive environment, with athletes competing against each other, which likely maximized motivation and performance. To ensure comparable recovery before the second day of testing, athletes were asked to refrain from additional high-intensity exercise on that day. On the second day, in accordance with the new Olympic canoe sprint competition format, participants completed two additional trials separated by approximately 2 h of passive recovery, simulating a semifinal and a final, respectively. To equate the relative effort before the second trial, the first trial of the day was performed using an even-pacing (EP) strategy, in which athletes maintained a power output matching the average recorded in the SP trial, reaching this target within the first 15 seconds. In the second trial, athletes performed a 15-s all-out start and then maintained power using a self-paced strategy. Athletes were aware that this effort would be maximal, but it was only a few minutes before the attempt that they were instructed on the details of the all-out (AO) strategy. During the recovery period between trials, athletes were restricted to consuming only low-sugar, non-caffeinated beverages to minimize the potential confounding effects of nutritional intake on performance in the second test.

Each trial was preceded by a standardized 10-min warm-up consisting of continuous paddling at a heart rate of 110–130 beats/min and two 5–7-s submaximal accelerations performed between minutes 7 and 9, followed by 2–3 min of passive rest before the beginning of the trial. Verbal encouragement was provided consistently during all trials to promote maximal and comparable motivation.

Mechanical parameters, including power output (PO) and stroke rate (SR), were continuously recorded using the manufacturer's software (Dansprint Analyzer Software, version 1.0). Based on SR data, the total stroke count was calculated for each trial. Consistent with the approach of Bishop et al., average power output was selected as the criterion for kayak ergometer performance.¹⁵ Additionally, average power was chosen as the primary outcome measure because it represents the direct mechanical work performed and has demonstrated high reliability (CV $\sim$ 1.6%) on this specific ergometer,¹⁹ whereas simulated distance is a derived variable calculated via a drag algorithm, for which the measurement precision (CV%) has not been established. Oxygen uptake (VO_2) was measured on a breath-by-breath basis using a metabolic cart (Vmax29, SensorMedics, USA), and heart rate (HR) was monitored with a heart rate monitor (Vantage NV; Polar Electro, Finland). For each trial, total oxygen uptake was calculated. Three minutes after each trial, capillary blood samples were collected from the fingertip: 20 μL for lactate analysis (LP 400 photometer and LKM 140 kits, Dr. Bruno Lange GmbH, Germany) and 70 μL for acid–base assessment (Ciba Corning 248 blood gas analyzer, USA). Base deficit was calculated as the negative value of base excess (–BE).

Statistical analysis

Results are presented as means and standard deviations (SD).

Before analysis, the assumptions of normality (Shapiro–Wilk test) and sphericity (Mauchly test) were verified. Differences between mean values of the measured variables across the three pacing strategies were assessed using repeated-measures analysis of variance (RMANOVA). When appropriate, post hoc comparisons were performed using the Bonferroni correction. The significance level was set at $P < .05$ for all tests. Effect sizes were estimated using partial eta squared (η_p^2), and interpreted using conventional benchmarks: small $\approx .01$, medium $\approx .06$, and large $\approx .14$.²⁰ All analyses described above were conducted using Statistica 13.3 (TIBCO Software Inc., Palo Alto, CA, USA). To assess the robustness of the findings given the relatively small sample size ($n = 9$), a Bayesian RMANOVA was also performed in JASP (version 0.95.0, JASP Team, Amsterdam,

The Netherlands) using the software's default prior settings. The Bayes factor (BF_{10}) was interpreted according to Jeffreys' scale.²¹ Specifically, BF_{10} values were classified as indicating strong ($BF_{10} < 0.10$), moderate ($0.10–0.33$), or anecdotal ($0.33–1.00$) evidence for the null hypothesis (H_0), and anecdotal ($1–3$), moderate ($3–10$), or strong (>10) evidence for the alternative hypothesis (H_1). Post hoc comparisons were adjusted for multiple testing using the null control procedure (Westfall correction).

Results

Figure 1 illustrates the time course of power output, stroke rate, oxygen uptake, and heart rate during the simulated 1000-m kayak race under the three pacing strategies.

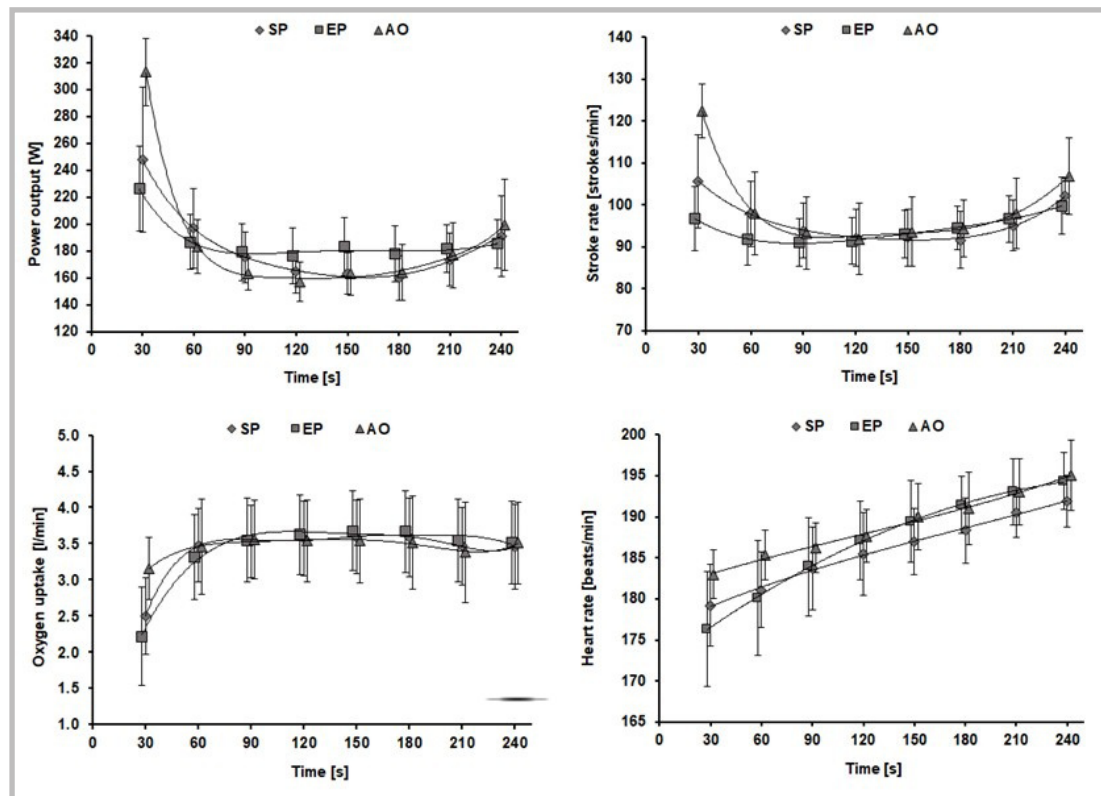


Figure 1. Power output, stroke rate, oxygen uptake, and heart rate during a simulated 1000-m kayak race performed with three pacing strategies: self-paced (SP), even-paced (EP), and all-out start (AO).

A significant main effect of pacing strategy was observed for average power output ($P = .023$, $\eta_p^2 = .38$) and peak heart rate ($P = .036$, $\eta_p^2 = .34$) (Table 1). Post hoc analysis showed that the

AO strategy resulted in a significantly higher ($P = .027$) average power output (194 ± 14 W) compared with the SP strategy (185 ± 22 W).

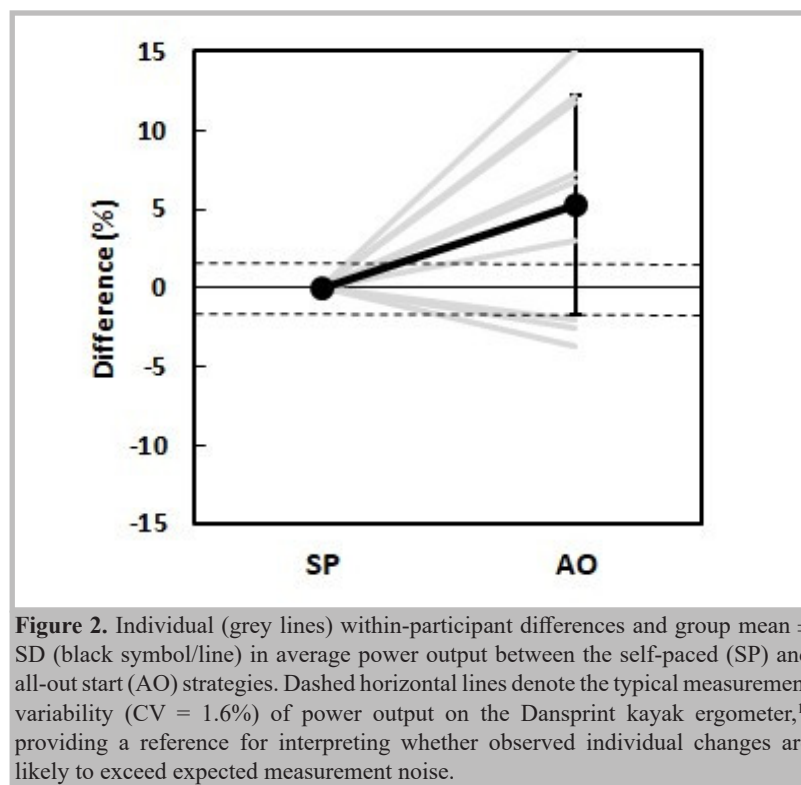
Table 1. Mean $\pm$ SD values from the three pacing strategies in a simulated 1000-m kayak race, with repeated-measures ANOVA results, post hoc tests, and effect sizes.

	SP	EP	AO	P-values	Effect sizes (η_p^2)
Average power output (W)	185 ± 22	187 ± 20	194 ± 14^a	.023	.38
Total stroke count (strokes/4 min)	386 ± 21	378 ± 20	399 ± 28	.052	.31
Peak heart rate (beats/min)	192 ± 3	194 ± 4	195 ± 4^a	.036	.34
Peak oxygen uptake (L/min)	3.82 ± 0.40	3.87 ± 0.38	3.84 ± 0.39	.680	.05
Total oxygen uptake (L/4 min)	14.0 ± 1.4	14.0 ± 1.6	14.3 ± 1.5	.358	.12
Lactate (mmol/l)	13.8 ± 3.1	13.7 ± 3.2	13.4 ± 3.2	.666	.05
pH	7.18 ± 0.07	7.17 ± 0.07	7.17 ± 0.07	.629	.06
Base deficit (mmol/l)	15.5 ± 2.7	15.3 ± 2.6	15.2 ± 3.0	.849	.02

SP – self-paced, EP – even-paced, and AO – all-out start strategies. ^aSignificantly different from SP.

These findings are complemented by Figure 2, which illustrates individual differences in average power output between the SP and AO strategies together with mean $\pm$ SD values. The figure highlights inter-individual variability in responses; while the

magnitude of change differed between participants, a consistent increase in power output was evident in the majority of athletes, aligning with the overall group-level improvement.



Bayesian analysis of average PO provided anecdotal evidence supporting the superiority of AO over both the SP and EP strategies ($BF_{10} = 1.82$ and 2.46 , respectively) (Table 2).

Peak heart rate was significantly higher during AO (195 ± 4 beats/min) than during SP (192 ± 3 beats/min; $P = .045$), with Bayesian analysis indicating moderate evidence for this

Table 2. Summary of Bayesian repeated-measures ANOVA (BF_{10} for model) and post hoc pairwise comparisons expressed as Bayes Factors.

	BF_{10} (model)	Strength of evidence	Direction of pairwise differences with BF_{10}
Average power output (W)	2.74	Anecdotal for H_1	AO > EP ($BF_{10} = 2.46$); AO > SP ($BF_{10} = 1.82$); EP $\approx$ SP ($BF_{10} = .46$)
Total stroke count (strokes/4 min)	1.83	Anecdotal for H_1	AO > EP ($BF_{10} = 3.72$); AO $\approx$ SP ($BF_{10} = .72$); EP $\approx$ SP ($BF_{10} = .50$)
Peak heart rate (beats/min)	2.22	Anecdotal for H_1	AO > SP ($BF_{10} = 4.22$); SP $\approx$ EP ($BF_{10} = .99$); AO $\approx$ EP ($BF_{10} = .39$)
Peak oxygen uptake (L/min)	.29	Moderate for H_0	—
Total oxygen uptake (L/4 min)	.43	Anecdotal for H_0	—
Lactate (mmol/l)	.29	Moderate for H_0	—
pH	.31	Moderate for H_0	—
Base deficit (mmol/l)	.25	Moderate for H_0	—

SP – self-paced, EP – even-paced, and AO – all-out start strategies. H_1 – evidence for difference, H_0 – evidence for no difference.

Pairwise post hoc comparisons were performed only when the model's Bayes Factor (BF_{10}) was greater than 1. > difference between strategies, $\approx$ no difference between strategies.

difference ($BF_{10} = 4.22$). For total stroke count, the main effect of pacing strategy did not reach statistical significance ($P = .052$, $\eta p^2 = .31$). However, Bayesian analysis suggested moderate evidence that AO resulted in a higher stroke count than the EP strategy ($BF_{10} = 3.72$). No significant differences were observed among the three pacing strategies for peak oxygen uptake, total oxygen uptake, lactate concentration, pH, or base deficit (all $P > .35$). Bayesian analysis provided anecdotal to moderate evidence

in favor of the null hypothesis for these variables (BF_{10} ranging from 0.25 to 0.43).

Discussion

This study aimed to examine whether adding an all-out start (AO) to a self-paced strategy increased average power output as a measure of performance in a fixed-duration 4-min kayak

ergometer trial simulating a 1000-m kayak race under the new Olympic canoe sprint schedule, and whether this pacing modification altered physiological responses. Our main finding was that a 15-s all-out start increased average power output during the 4-min trial without a proportional rise in physiological cost. Frequentist and Bayesian analyses supported this result, suggesting that a brief all-out start may be worth considering as a pacing option for the 1000-m canoe sprint under the Olympic regatta schedule.

These findings support previous observations that pacing strategies based on initiating the effort at maximal or near-maximal intensity can maximize performance in middle-distance races,^{10,11} including sprint kayaking.¹⁵ They therefore contradict studies that did not report performance benefits from such strategies.^{12–14} It is worth noting, however, that in those latter studies, the strategy involved maintaining very high speeds over the first 300 m of 1500-m efforts on skates and a cycle ergometer; thus, the starting phase lasted much longer (>25 s) than in our experiment. Such a prolonged fast-start phase would likely lead to a greater contribution from anaerobic glycolysis, which could accelerate muscle acidification and impair the ability to sustain power, particularly toward the end of the effort.⁵ It is also notable that other authors observed that, although a 15-s all-out start improved performance in a 1500-m cycling time trial, an initial sprint lasting 90 s yielded results that did not differ from those obtained with a self-paced strategy.²²

One possible explanation for these observations may lie in the bioenergetics of maximal effort. During the first few seconds of maximal effort, phosphocreatine is the dominant source of ATP resynthesis, and this dominance continues until approximately 15 s.²³ Because the creatine kinase reaction consumes hydrogen ions,⁴ the muscle acidification typically associated with glycolysis-driven high-intensity exercise does not occur during this phase.^{5,24} This may suggest that a brief maximal-intensity start, lasting no longer than ~15 s, could allow athletes to maximize early power output without the metabolic consequences typically associated with anaerobic glycolysis. Consistent with this hypothesis, our athletes achieved significantly greater average power when beginning the trial with maximum effort compared with a self-paced strategy. Similar benefits of a short all-out start have also been reported in kayakers performing a 2-min effort simulating a 500-m race.¹⁵ Although in the final minute of that effort athletes were unable to generate as much power as with an even-paced strategy, their overall performance was higher. In contrast, recent research on the effects of an approximately 10-s all-out start on performance in a 4-km laboratory cycling time trial (completed in about 6 min 20 s) showed no benefit of this strategy.²⁵ Notably, while benefits of a fast-start strategy were reported in a 5-min effort,²⁶ the same authors did not observe such benefits in a 6-min effort.²⁷ These contrasting findings suggest that the effectiveness of a fast-start strategy may be duration-dependent, though the specific duration threshold beyond which this strategy ceases to be beneficial remains to be determined.

The effects of prior exercise on subsequent performance have also been explored in cycling, where priming exercise, alone or in combination with a fast-start strategy, has been shown to accelerate oxygen-uptake kinetics and improve time-trial performance.^{28,29} However, in those protocols the priming bouts and subsequent performance tests were relatively short and were performed at heavy but submaximal intensities. In contrast, in our study the AO trial was conducted ~2 h after a 4-min effort at a power output corresponding to that achieved in the maximal

self-paced trial.

Instead of acting as a beneficial preparatory stimulus, we hypothesize that this preceding 4-min effort at a power output corresponding to that achieved in the maximal self-paced trial may have induced residual fatigue that persisted during the AO trial. Support for this hypothesis comes from studies of 4000-m individual pursuit (~4 min) in World Championship track cycling,³⁰ where elite athletes experienced significant performance decrements (~2.5 s) in the final compared with the qualifying round, despite an average recovery period of 6.5 h between races. These observations suggest that even substantially longer recovery periods than the 2 h used in the current study may be insufficient for full physiological restoration after maximal efforts lasting approximately 4 min. Furthermore, other research has shown that highly trained individuals recover more rapidly than moderately trained subjects after high-intensity exercise.³¹ Therefore, although we did not collect objective recovery data in the present study, it is plausible to suggest that these national-level athletes performed the AO trial in a state of incomplete recovery, which may have constrained their performance. This interpretation remains speculative and is inferred from previous literature rather than from direct recovery measurements in our study.

Although conventional (frequentist) statistical analysis did not detect a significant difference in total stroke count between strategies ($P = .052$), Bayesian inference indicated stronger support for a difference between AO and EP ($\text{BF}_{10} = 3.72$). Given that total stroke count in our trials directly reflected mean stroke rate, this finding may further support the association between stroke rate and power output observed in actual kayak races.¹⁷ Using the AO strategy, athletes achieved significantly higher peak heart rates than in the SP strategy (AO: 195 ± 4 vs SP: 192 ± 3 beats/min; $P = .036$), but values were almost identical to those recorded during the EP trial (194 ± 4 beats/min), which was performed about 2 h before the AO trial. The difference in peak heart rate between AO and the SP trial performed the previous day was supported by moderate evidence from Bayesian analysis ($\text{BF}_{10} = 4.22$). It is worth noting, however, that these differences fell within the typical range of day-to-day variability in peak heart rate, which has been estimated at 2–4 beats/min.³²

In contrast to peak heart rate, none of the other physiological variables differed significantly between strategies. Bayesian analysis supported this observation, providing anecdotal to moderate evidence in favor of the null hypothesis for these variables (BF_{10} ranging from 0.25 to 0.43). The absence of differences in these indicators may reflect similar physiological cost in all three trials. Moreover, lactate concentrations and pH values were comparable to those reported in other kayakers performing maximal efforts,¹⁵ and, consistent with those findings, did not differ according to pacing strategy in the present study. Taken together, these findings suggest that the AO strategy, despite generating the highest average power, did not entail additional physiological cost. Consequently, the advantage of this strategy appears to result from a more efficient distribution of intensity rather than from greater physiological demand or the influence of confounding factors. The close agreement between the lactate concentrations observed in our study and those recorded under real competition conditions³³ further supports the high ecological validity of the research protocol.

This study has several limitations that should be acknowledged. First, the fixed and nonrandomized order of experimental conditions does not allow for the complete isolation of the pacing strategy's effect from potential confounding variables, such as day-to-day variability, trial order, or accumulated

fatigue. However, the fixed protocol was deliberately designed to replicate the temporal structure of a semifinal followed by a final separated by approximately 2 h, reflecting the current Olympic regatta schedule. Although ergometer testing cannot fully replicate on-water racing conditions in terms of hydrodynamic and technical demands (see below), preserving this scheduling constraint was considered important to approximate the temporal recovery demands athletes face in competition. Furthermore, because the athletes were already familiar with maximal-effort testing on the ergometer from regular club assessments, and because the pacing strategies tested represent commonly used racing approaches rather than novel motor tasks, any learning effects were likely negligible. Accordingly, interpretations regarding incomplete recovery and the optimal duration of the fast-start phase should be considered as preliminary evidence requiring confirmation rather than definitive conclusions. Future studies should consider incorporating randomized or counterbalanced designs to disentangle strategy effects from potential order-related confounds, even if this comes at some cost to the ecological validity prioritized in the present study. Second, the small sample size ($n = 9$) of national-level athletes limits generalizability. While low statistical power is a concern in frequentist analyses, the complementary Bayesian approach provided consistent results, strengthening confidence in the observed effects despite the limited sample. Nevertheless, replication with larger cohorts is warranted. Third, although the AO strategy increased average power output at the group level, individual responses varied (Figure 2). While most athletes improved under AO, the magnitude of change differed between participants. Importantly, the observed mean improvement ($+9$ W, $\sim 5.3\%$) substantially exceeds the measurement variability for this ergometer ($CV \sim 1.6\%$),¹⁹ suggesting that the group-level difference is unlikely to be attributable solely to measurement noise. At the individual level, responses were more heterogeneous, and the relative contribution of true inter-individual differences versus day-to-day variability or order effects cannot be fully determined in the present design. Future studies with larger samples and counterbalanced designs should aim to identify factors that predict responsiveness to different pacing strategies. Fourth, although kayak ergometers allow for controlled and reliable assessment of mechanical and physiological responses, they cannot fully replicate the hydrodynamic resistance, balance demands, and technical variability of on-water kayaking. Specifically, small fluctuations in power output on water may result in disproportionately larger decelerations compared to the flywheel-resisted ergometer. Furthermore, the metabolic disturbances associated with certain pacing strategies could reduce technical efficiency, which is more critical for boat propulsion than for ergometer performance. Accordingly, the observed increase in average power should not be assumed to translate directly into faster on-water race times or improved race placing, and caution is required when extrapolating the present findings to competitive racing conditions.

Practical applications

Coaches and athletes may consider incorporating a 15-s all-out start phase when planning pacing strategies for 1000-m canoe sprint races. This approach can increase average power output without increasing physiological cost, even when recovery time between races is limited. The strategy may also have potential relevance for other middle-distance power-endurance events. However, further research is required to confirm the transferability of these benefits to other events with similar

physiological demands.

Conclusions

In summary, a 15-s all-out start may offer modest but potentially meaningful increases in average power output during fixed-duration 4-min kayak ergometer trials simulating 1000-m kayak races under Olympic-style conditions. This improvement was not accompanied by an increased physiological response, suggesting that it resulted from more efficient regulation of intensity rather than from greater exertion. The consistency of these results across both frequentist and Bayesian analyses strengthens confidence in the observed effects, although they should be interpreted with caution given the study's limitations.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Ethical Committee approval

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Author-s contribution

Conceptualization: DS; Methodology: DS; Validation: DS, PŻ, AK; Formal analysis: DS; Investigation: DS; Resources: AK; Data curation: DS, AK; Visualization: DS; Supervision: PŻ, AP, AK; Project administration: AK; Writing-original draft: DS, PŻ, AP.

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