Over-estimation of required recovery time during repeated sprint exercise with self-regulated recovery

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Abstract

This study investigated the reliability and accuracy of self-regulated recovery time and performance during repeated sprinting. On four occasions, 14 men (24.5 ± 5.0 y) completed 10 x 6 sec cycle sprints against 7.5% body mass, self-regulating (SR) recovery time to maintain performance. Subjects then repeated the test but with a reduced recovery (RR) of 10% less recovery time. Across the first four trials, there were no between-trial differences in peak power output (PPO) or mean power output (MPO), recovery time, or fatigue index ($P > 0.05$). Random variation in recovery time was reduced across trials 3-4 (CV = 7.5%, 95% confidence limits (CL) = 5.4-12.4%) compared to trials 1-2 (CV = 16.0, 95% CL = 11.4 to 27.0%) and 2-3 (CV = 10.1%, 95% CL = 7.2 to 16.7%), but was consistent across trials for PPO and MPO (between-trials CV ≤ 3.3%). There were no trial effects for any performance, physiological, or perceptual measures when comparing SR to RR ($P > 0.05$), although heart rate and perceptual measures increased with subsequent sprint efforts ($P < 0.05$). Following two familiarisation trials, subjects can reliably self-regulate recovery time to maintain performance during repeated sprints. However, subjects overestimate the amount of recovery time required as reducing this time by 10% had no effect on performance, perceptual or physiological parameters. Self-regulated sprinting is potentially a reliable training tool, particularly for sprint training where maintenance of work is desired. However, over-estimation of required recovery time means that performance improvements may not be achieved if the goal of training is improvement of repeated sprint performance with incomplete recovery.

Key Words: pacing; power output; self-regulation; fatigue.

INTRODUCTION

Repeated sprint exercise is common across many sports and in experimental research (5,15,17). Performance determinants evaluated in repeated sprint tests include speed or power output, and fatigue resistance (18). Quantification of maximum sprint speed/power shows good test-retest reliability (30). Conversely, the best method of quantifying fatigue index (FI) reports a coefficient of variation (CV) of ~30% (16,17). This large variability may hamper understanding of regulatory processes underpinning performance during, and improvements gained from, repeated sprint exercise.

Pacing tactics may be employed before or soon after exercise begins in a feed-forward fashion, to prevent significant homeostatic disturbance and premature exercise termination (29). Billaut et al. (7) reported that prior knowledge of the required number of sprints influences power output during a repeated sprint protocol, suggesting that anticipatory self-regulated (SR) pacing may happen during repeated sprint exercise. However, self-regulation was confined to power production as the recovery periods between sprints were fixed.

Glaister et al. (18) further investigated self-regulation of performance during 12 x 30 m running sprints by allowing subjects to choose their own recovery time based on individual perceptions of recovery. Following two familiarisation trials, subjects were able to self-regulate recovery to maintain a consistent performance (mean CV for recovery time between sessions 3-4 of 9.9%). Glaister et al. (18) suggested that these findings justify self-regulation of repeated sprinting as a reliable tool for individuals to quantify their level of fatigue and maintain the quality of repeated sprint sessions. Self-regulation of repeated sprint performance in line with individual physical capabilities would be beneficial in many sport and exercise training scenarios, particularly when individuals train in groups. However, the protocol employed by Glaister et al. (18) could not quantify the accuracy of SR repeated sprinting. Therefore, it could not be determined whether

subjects overestimated recovery time to allow them to maintain performance. This should be investigated, as the recovery time chosen would influence the physiological demand experienced during the bout (4). Full recovery, defined for the purposes of the current study as a return to resting metabolic and intramuscular energy status, is not required for repeated sprint performance to be maintained (15). If SR recovery is over-estimated, meaning that subjects give themselves more recovery than is actually necessary to maintain repeated sprint performance, then allowing athletes to self-regulate their performance may not generate the physiological load required to stimulate specific adaptations and performance enhancements, or prepare athletes sufficiently for the demands of competition. This can be experimentally tested by establishing individual SR recovery and then reducing this recovery time in a blinded fashion. If such an approach alters physiological and perceptual responses and impairs repeated sprint performance, it would provide an insight into the accuracy of self-regulating repeated sprinting. Currently, no specific research is available that addresses these issues.

The aim of this study was to investigate the reliability of SR performance during repeated sprint exercise and the accuracy of this self-regulation. It was hypothesised that following appropriate familiarisation, self-regulation of repeated sprint exercise would allow maintenance of a stable performance level, and that reducing SR recovery duration would impair repeated sprint performance.

METHODS

Experimental Approach to the Problem

Learning effects exist between the first two trials of a cycle sprint test (22). Therefore, to ensure sufficient data for familiarisation and reliability analysis, subjects completed four trials (18) each comprising 10 x 6 sec cycle sprints on a Monark 894E mechanically braked cycle ergometer against

a 7.5% body mass (BM) resistance. Subjects SR the recovery duration between each sprint with the goal of maintaining a stable power output across all sprints. All subjects maintained sprint performance across the four trials, and therefore took part in a fifth trial. Recovery time was manipulated in a single-blind fashion to investigate the accuracy of SR repeated sprint performance. Each subject's most reliable SR performance from trial 3 or 4 (based on within-trial coefficient of variation (CV) for mean power output (MPO)) was used as the criterion recovery time to manipulate. Each post-sprint recovery time was reduced by 10% (reduced recovery (RR) trial). The ergometer was attached to specialist software (Monark Anaerobic Test Software 3.2.5.5, Vansbro, Sweden) that enabled calculation of peak power output (PPO), MPO, and FI for each sprint. Heart rate (HR), physical ratings of perceived exertion (P-RPE) and measures of task effort awareness (TEA) were recorded during each trial to provide an indication of physiological and psychological strain. Within subjects, all trials were conducted at the same time of day, with a minimum of 3 and maximum of 7 days between trials. Subjects completed a food diary for 24 h before the first trial and were instructed to replicate this before each trial, to control for the potential influence of alterations in energy intake on mood state (9) and performance (24). Subjects were asked to consume a light meal at least 2 h before testing. Pre-testing training was not standardised between subjects, but was standardised within subjects by requesting that they refrain from strenuous exercise for at least 24 h before each trial. Adherence to these procedures was verbally confirmed at the beginning of each trial.

Subjects

Fourteen healthy, recreationally active males (24.5 ± 5.0 y, 178 ± 8 cm, 80.9 ± 13.2 kg) participated, some of whom had experience of repeated cycle sprinting. Subjects took part in a variety of sports (gym training, climbing, football, hockey, volleyball, martial arts) for a mean weekly duration of 6.5 ± 3.9 h and a mean experience level of 8.1 ± 5.3 years. Subjects were informed of the nature of the

111 investigation, after which they gave written informed consent. The study received approval from the
112 Institutional Research Ethics Committee.
113
114 Procedures
115
116 Body mass (BM, kg) and standing height (cm) were recorded using a height stadiometer (Seca model
117 245, Hamburg, Germany) and digital scale (Seca model 708, Hamburg, Germany) respectively while
118 wearing shorts. Subjects then completed a standardised warm-up of 4 min cycling at 60 rpm against
119 a 1 kg resistance, and 3 x 3 s maximal sprints against a 7.5% BM resistance interspersed with 45 s
120 cycling against no resistance. They then dismounted and sat quietly for 3 min prior to the main
121 component of the trial. In each trial, subjects were informed that they were to complete 10 x 6 s
122 cycle sprints, to give maximum effort in each sprint, and to give themselves sufficient recovery so
123 that in all ten sprints they were able to replicate the performance achieved in the criterion sprint
124 (instructions adapted from Glaister et al. (18)). Subjects were instructed to remain seated during all
125 sprints. No external performance feedback was provided but cadence was visible during recovery
126 periods. Vigorous verbal encouragement was provided during every sprint. Subjects were instructed
127 to give a 3 s countdown before starting each sprint, and to factor this into their recovery. Recovery
128 time was defined as the period from the end of the previous sprint until the beginning of the next
129 sprint, immediately following the 3 s countdown. All sprints began from 60 rpm with resistance
130 automatically applied to the flywheel upon reaching 110 rpm.
131
132 *Trial 1*
133
134 A flow chart summarising the experimental protocol is in Figure 1. Subjects were introduced to the
135 equipment and procedures. They then undertook a single 6 s sprint to familiarise them with the
136 procedure and provide criterion sprint data for comparison with repeated sprint performance.
137 Following the warm up, subjects remounted the ergometer and cycled at 60 rpm against no resistance

for 10 s, after which they cycled maximally. The load was automatically added to the ergometer upon reaching 110 rpm, at which time the 6 s sprint began. On completion, participants cycled easily against a 1 kg resistance for 1 min, then dismounted the ergometer and sat quietly for 5 min. The test was repeated to identify whether a maximal effort was achieved in the first sprint. If subjects achieved a lower MPO in test 2, the result of test 1 was taken as MPO. If subjects achieved a MPO in test 2 $\geq$ 5% greater than test 1, a third test was undertaken. This was repeated as necessary until MPO no longer increased. A 15 min seated recovery followed the criterion sprint test.

Following the recovery, participants completed the standardised warm up, then remounted the ergometer and cycled at 60 rpm for one minute. The investigator provided a 3 s countdown, after which the subject completed 10 x 6 s cycle sprints against a 7.5% BM resistance with a self-regulated recovery between each sprint. During recovery, participants cycled at 50-60 rpm against no resistance.

Trials 2-4

Trials 2-4 followed a similar procedure to that of trial 1. However, only the warm up and the 10 x 6 s sprints were completed.

Following the first four trials, subjects' data were analysed to determine if they successfully maintained sprint performance in each trial. Performance maintenance was defined as:

1. The absence of an obvious pattern of fatigue, determined by visual inspection of PPO and MPO data for each sprint (18), to confirm no continuous drop-off in performance.
2. A within-trial CV for MPO of 5.2% or less (the upper CV of MPO for this type of exercise (10,18)).

All subjects successfully maintained performance in the first four trials, and progressed to the final trial.

Trial 5

In this trial, SR recovery time was manipulated as described above. The 10% reduction in recovery times is greater than the random variation of recovery time previously reported during self-paced recovery of repeated sprints (18). However, prior to the session subjects were informed that their most reliable sprint session was being replicated to investigate repeatability of performance. They were reminded that they should produce their best effort, but this time the investigator would tell them when to begin each sprint. The investigator informed the subject when there was 10 s of a recovery period remaining, and provided a 3 s countdown into the next sprint.

Figure 1 here

In addition to power data, HR was recorded (Polar S610i, Kempele, Finland) at 5 s intervals throughout each trial. Fatigue index was calculated using the formula (18):

Fatigue index = (100 x (total sprint performance / ideal sprint performance)) – 100

Where total sprint performance = sum of MPO from all sprints, and ideal performance = number of sprints x greatest MPO. Self-regulated recovery duration between each sprint was recorded with a digital stopwatch to the nearest s (11). Physical ratings of perceived exertion and TEA were recorded 5 s after every sprint using procedures described by Swart et al. (27). These scales separately quantify physical and psychological effort during exercise, enabling greater insight into the influence of these factors on exercise performance (27).

Statistical Analyses

Between-trials reliability was assessed by calculating changes in the mean, intraclass correlation coefficient (ICC), CV, and 95% limits of agreement (LoA) using published spreadsheets (20,21). One-way repeated measures ANOVA compared mean recovery time between trials 1-4, and PPO and MPO between the criterion sprint and all sprints in the SR and RR trials. Physiological, perceptual, and performance measures from each subject's most reliable repeated sprint trial (based on within trial recovery time) from the first four sessions was compared to the RR trial using a two-way (trial x sprint) ANOVA. The Greenhouse-Geisser adjustment was applied if the assumption of sphericity was violated, and post-hoc Bonferroni correction explored significant main effects. Pearson correlations between sprint number and perceptual responses, and between P-RPE and TEA, were calculated for each subject. Effect sizes for significant main effects from ANOVA analysis were reported as partial eta-squared (η_p^2) and quantified as small (≤ 0.01), medium (> 0.01, < 0.14), and large (≥ 0.14; 13). Cohen's *d* effect sizes quantified the magnitude of significant mean differences between trials (small, $d \leq 0.2$; medium, $d > 0.2$, < 0.8; large, $d \geq 0.8$; (12)). Statistical significance was set at $P \leq 0.05$, and data are mean ± SD unless otherwise stated.

RESULTS

Mean results for each performance variable across the four reliability trials are in Table 1. There were no differences across trials for any performance variable ($P > 0.05$). Reliability statistics are in Table 2. Random variation of recovery time (CV and LoA) was substantially reduced when comparing the final pair of trials to earlier pairs of trials. Both MPO and PPO demonstrated ICCs > 0.95 and CVs ≤ 3.3% in all comparisons. Conversely, there were high levels of random variation in FI.

Tables 1 & 2 here

As designed, mean recovery time was significantly reduced in the RR trial compared with the SR trial (86.2 ± 31.6 vs. 95.7 ± 35.2 s, $P < 0.05$, $d = 0.28$), with the reduced recovery time lower than that chosen by each participant in trials 3 and 4. There was no significant effect of sprint number for mean recovery time ($F_{2.69,34.94} = 0.482$, $P > 0.05$, $\eta_p^2 = 0.07$). Power profiles across the SR and RR sprints, and compared to the criterion sprint, are in Figure 2A and B. There was no significant main effect for PPO for trial ($F_{1,13} = 0.134$, $P > 0.05$, $\eta_p^2 = 0.01$) or sprint number ($F_{3.66,47.54} = 0.820$, $P > 0.05$, $\eta_p^2 = 0.06$) and no interaction effect ($F_{4.13,53.74} = 0.973$, $P > 0.05$, $\eta_p^2 = 0.07$). There was no main effect for trial ($F_{1,13} = 1.163$, $P > 0.05$, $\eta_p^2 = 0.08$) or sprint number ($F_{3.01,39.12} = 0.452$, $P > 0.05$, $\eta_p^2 = 0.03$) and no interaction effect ($F_{2.78,35.98} = 0.840$, $P > 0.05$, $\eta_p^2 = 0.06$) for MPO. There was no significant difference in MPO between the criterion sprint and any sprint in the SR ($F2.76,35.86 = 2.099$, $P > 0.05$, $\eta_p^2 = 0.14$) and RR trials ($F_{2.96,38.53} = 1.161$, $P > 0.05$, $\eta_p^2 = 0.08$). However, PPO in the criterion sprint was significantly greater than PPO in all sprints of the SR trial ($F_{3.396,44.144} = 3.114$, $P < 0.05$, $\eta_p^2 = 0.19$). In the RR trial, PPO in sprints 3-10 was significantly lower than the criterion sprint ($F_{10,130} = 2.621$, $P < 0.05$, $\eta_p^2 = 0.17$).

Figure 2 here

Perceptual responses to the SR and RR trials are in Figure 3A and B. There was no main effect of trial (P-RPE; $F_{1,13} = 0.034$, $P > 0.05$, $\eta_p^2 = 0.0$ and TEA; $F_{1,13} = 0.074$, $P > 0.05$, $\eta_p^2 = 0.0$) and no interaction effect between trials over time (P-RPE; $F_{3.05,39.70} = 0.920$, $P > 0.05$, $\eta_p^2 = 0.07$ and TEA; $F_{9,117} = 0.750$, $P > 0.05$, $\eta_p^2 = 0.06$). However, there was a significant time effect for both P-RPE ($F_{1.43,18.62} = 27.590$, $P < 0.05$, $\eta_p^2 = 0.68$) and TEA ($F_{1.42,18.44} = 21.950$, $P < 0.05$, $\eta_p^2 = 0.63$). The relationship between sprint number and perceived physical and psychological stress demonstrated wide inter-individual variability in the SR (P-RPE: $r^2 = 0.07$-0.98, TEA: $r^2 = 0.21$-0.88) and RR (P-RPE: $r^2 = 0.08$-0.92, TEA: $r^2 = 0.0$-0.94) trials. Similarly, the relationship between P-RPE and TEA

was r^2 = 0.28-1.0 in the SR trial and r^2 = 0-0.98 in the RR trial. Heart rate showed no main effect of trial ($F_{1,10}$ = 0.949, P > 0.05, η_p^2 = 0.09) or interaction effect ($F_{2.78,27.83}$ = 0.708, P > 0.05, η_p^2 = 0.07), but there was a main effect of time ($F_{3.54,35.35}$ = 41.269, P < 0.05, η_p^2 = 0.81; Figure 4).

Figure 3 here

DISCUSSION

Following two familiarisation sessions, subjects were able to maintain repeated sprint performance with relatively stable SR recovery periods. Reducing SR recovery duration by 10% did not impair maintenance of repeated sprint performance or affect psycho-physiological ratings. Therefore, subjects over-estimated required recovery time between sprints.

Table 2 shows a notable improvement in the reliability of SR recovery time between trials 1-2, 2-3, and 3-4. The high CV and low ICC for SR recovery time between trials 1-2 compared with trials 2-3 and 3-4 supports the suggestion of Hopkins et al. (22) that learning effects are evident between at least the first two trials of cycle sprint tests. The reliability of SR recovery between trials 3-4 in the current study (CV = 7.5%, ICC = 0.97) is better than that reported by Glaister et al. (18) across the same trials (CV = 9.9%, ICC = 0.83), and is also below the imposed 10% reduction of recovery time in the RR trial. Better reliability may relate to the exercise mode (running vs. cycling), or to the subjects used in the current study, some of whom had experience of repeated cycle sprinting. It should also be considered that maintenance of repeated sprint performance depends on sprint duration (1). Therefore, varying sprint duration may influence the ability to self-regulate performance. This should be considered when comparing results between studies, and may represent an interesting avenue for further research.

271 Glaister et al. (18) reported a progressive increase in RPE during repeated sprints, despite a stable
272 performance. This was attributed to subjects giving themselves just enough recovery between
273 sprints. In the current study, P-RPE and TEA scores progressively increased throughout both trials,
274 with no significant between-trials differences. The present findings support the observation that
275 while a self-selected recovery will allow performance to be maintained, perceived exertion
276 progressively increases. However, the present findings do not support the suggestion that subjects
277 pace recovery to give just enough time to maintain performance, as when recovery time was reduced
278 by 10% performance was still maintained.

279

280 In the current study, P-RPE was almost identical at the end of exercise in the SR and RR trials.
281 However, the peak values (~15) in the current study and that of Glaister et al. (18) likely do not
282 reflect the highest tolerable values that subjects could have attained. This is reinforced by the
283 moderate peak TEA values in both trials. Short-duration sprinting is fuelled by phosphocreatine
284 (PCr; ~50%) and glycolysis (~40%), with a progressive aerobic contribution as sprint number
285 increases (6). The duration of the recovery periods in the current study would likely have enabled a
286 continued large contribution of PCr to subsequent sprints, as the half-time of PCr resynthesis in
287 adults is ~27 s (28). Therefore, progressive intramuscular acidosis associated with the glycolytic
288 contribution to the sprints may explain the progressive increase in P-RPE and TEA (18). It has also
289 been shown that the aerobic contribution to repeated sprinting increases as the number of sprints
290 progresses (8). Increased aerobic contribution would require an increased cardiorespiratory demand,
291 increasing afferent feedback and potentially elevating RPE and TEA. The potential impact of
292 increased intramuscular acidosis and cardiorespiratory demand may also explain the variable
293 individual relationship between sprint number and perceived physical and psychological stress, as
294 between-subjects differences in aerobic fitness and muscle morphology may have modulated
295 metabolic responses (19,29) and, hence, perceptual responses to the sprints. Blood lactate
296 concentration was not measured in this study due to the large variability in blood lactate measures
297 and the greater reliance on PCr as a fuel during repeated sprinting. Therefore, further investigation is

298 required to elucidate these suggestions. Similar P-RPE, TEA, and HR between the SR and RR trials
299 reinforces that when subjects are permitted to select their own recovery, they over-estimate the
300 recovery required to maintain performance by at least 10%.
301
302 Deception of the number of sprints (with known sprint and recovery duration) to be performed can
303 significantly reduce PPO and work performed from the first sprint, suggesting the presence of a
304 pacing strategy based on factors including the number of sprints required (7). From a practical
305 perspective, pacing during repeated sprint exercise may impair training quality and fitness
306 adaptations. In the SR trial, subjects produced a significantly lower PPO from sprint one compared
307 with the criterion sprint. It therefore appears that when subjects were aware that they had to perform
308 multiple sprints, even with a self-selected recovery, they produced submaximal power from the onset
309 of exercise despite being asked to perform maximally. Submaximal power production could be the
310 result of an anticipatory pacing strategy based on knowledge of the number of sprints to be
311 completed (7), or it may be that experience of completing repeated 6 sec sprints enabled the subjects
312 to pace differently within each sprint, achieving a lower PPO but maintaining MPO (Figure 2A and
313 B). In the current study, it is not possible to determine the relative prevalence of these hypotheses.
314 Billaut et al. (7) did not employ a single criterion sprint. Therefore, the true maximal performance of
315 their subjects was unknown, meaning inferences regarding pacing strategies could only be made by
316 comparing between-trials sprint performance during exercise. By comparing repeated sprint
317 performance to that of a single sprint, this study provides the first evidence for sub-optimal
318 performance from the onset of a known bout of repeated sprinting in recreationally trained subjects.
319 This finding reinforces the presence of a pacing strategy based either on anticipation of the number of
320 sprints to be completed and/or based on prior experience of the repeated sprint protocol.
321
322 It is well known that the type of pacing strategy employed during exercise is influenced by previous
323 related exercise experience (2,25) and the performance level of the subject (23). Possible
324 determinants of the pacing strategies used by different standards of athlete include differences in

physiological and psychological parameters (3,23), and the learnt aspect of pacing that is developed through experience (14). The current study used recreationally trained subjects. Therefore, it cannot be conclusively asserted that using SR recovery in more highly trained and/or experienced athletic populations would generate the same findings as reported in the current study, or would be a useful strategy for athletes. Future research should explore the influence and efficacy of SR recovery in more elite populations.

In conclusion, following two familiarisation trials repeated cycle sprinting performance can be reliably maintained when subjects self-regulated recovery. However, subjects also over-estimate by at least 10% the recovery time needed to maintain sprint performance.

PRACTICAL APPLICATIONS

Self-regulated recovery appears to be a reliable option for maintaining the quality of repeated sprint exercise and resisting fatigue. This has particular practical relevance when training groups of individuals with differing repeated sprint abilities. Coaches could employ SR repeated sprinting as a method of maintaining sprint quality tailored to individual performance, rather than using a single fixed recovery period, which may not suit the ability of all individuals. However, this study has demonstrated that individuals over-estimate the recovery time needed for maintenance of performance. Many sporting situations require repeated bouts of effort with minimal recovery (26). Therefore, if a goal of training is to prepare for this situation, then allowing individuals to self-regulate recovery may not stimulate the necessary metabolic adaptations for performance improvement. Coaches should be aware of the potential benefits and limitations of SR repeated sprinting, and consider the use of SR recovery within the context of specific training aims. The findings of this study should also be treated as population specific, until subsequent work has been conducted in more elite populations to investigate whether or not high performing athletes display similar responses to SR repeated sprint exercise.

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Figure Captions

Figure 1. Flow diagram summarising the experimental protocol.

Figure 2. Peak power output (A) and mean power output (B) across the criterion sprint (C) and repeated sprint efforts with self-regulated recovery (filled circles) and reduced recovery (open circles). * significantly greater than sprints 1-10 in the SR trial ($P < 0.05$); ** significantly greater than sprints 3-10 in the RR trial ($P < 0.05$).

Figure 3. Physical ratings of perceived exertion (A) and task effort and awareness ratings (B) following each sprint effort in the self-regulated (filled circles) and reduced recovery (open circles) trials. † Significant main effect of sprint number ($P < 0.05$).

Table 1. Mean (± SD) performance variables across the four trials of self-regulated repeated sprint exercise.

	Trial 1	Trial 2	Trial 3	Trial 4
Recovery time (s)	90.3 ± 26.8	92.4 ± 35.5	94.8 ± 33.1	96.1 ± 33.8
Mean power output ($W.kg^{-1}$)	10.93 ± 1.18	10.79 ± 1.21	10.76 ± 1.28	10.84 ± 1.16
Peak power output ($W.kg^{-1}$)	12.53 ± 1.75	12.25 ± 1.61	12.22 ± 1.69	12.20 ± 1.56
Fatigue index (%)	3.3 ± 1.4	4.1 ± 1.8	4.5 ± 2.0	3.9 ± 1.7

Table 2. Pairwise reliability of performance variables during self-regulated repeated sprint exercise.

		Δ Mean	ICC	CV	95% LoA
Recovery time (s)	Trial 1 to 2	2.14 (-10.57 to 14.86)	0.79 (0.48 to 0.93)	16.0 (11.4 to 27.0)	1.77 ±44.83
	Trial 2 to 3	2.36 (-7.15 to 11.87)	0.94 (0.82 to 0.98)	10.1 (7.2 to 16.7)	2.38 ±33.60
	Trial 3 to 4	1.36 (-3.80 to 6.51)	0.97 (0.90 to 0.99)	7.5 (5.4 to 12.4)	2.00 ±17.55
Mean power output ($W.kg^{-1}$)	Trial 1 to 2	-0.13 (-0.37 to 0.11)	0.96 (0.87 to 0.99)	2.7 (1.9 to 4.4)	-0.15 ±0.84
	Trial 2 to 3	-0.03 (-0.25 to 0.19)	0.97 (0.90 to 0.99)	2.4 (1.8 to 4.0)	-0.05 ±0.76
	Trial 3 to 4	0.08 (-0.08 to 0.24)	0.98 (0.94 to 0.99)	1.9 (1.3 to 3.0)	0.10 ±0.55
Peak power output ($W.kg^{-1}$)	Trial 1 to 2	-0.29 (-0.64 to 0.07)	0.96 (0.87 to 0.99)	3.3 (2.4 to 5.3)	-0.28 ±1.27
	Trial 2 to 3	-0.03 (-0.31 to 0.24)	0.97 (0.91 to 0.99)	2.7 (1.9 to 4.3)	-0.06 ±0.96
	Trial 3 to 4	-0.01 (-0.18 to 0.15)	0.99 (0.97 to 1.00)	1.6 (1.2 to 2.6)	0.00 ±0.56
Fatigue index (%)	Trial 1 to 2	0.75 (-0.43 to 1.93)	0.42 (-0.12 to 0.77)	47.8 (32.7 to 87.6)	0.57 ±3.92
	Trial 2 to 3	0.41 (-0.47 to 1.29)	0.72 (0.33 to 0.90)	33.9 (23.6 to 60.1)	0.65 ±2.48
	Trial 3 to 4	-0.61 (-1.84 to 0.63)	0.46 (-0.07 to 0.79)	47.3 (32.4 to 86.6)	-0.64 ±4.37

ICC = intraclass correlation coefficient; CV = coefficient of variation; 95% LoA = 95% Limits of Agreement; Values in parentheses are 95% confidence limits.