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Effects of Short-Term Training With Uncoupled Cranks in Trained Cyclists

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Purpose: Manufacturers of uncoupled cycling cranks claim that their use will increase economy of motion and gross efficiency. Purportedly, this occurs by altering the muscle-recruitment patterns contributing to the resistive forces occurring during the recovery phase of the pedal stroke. Uncoupled cranks use an independent-clutch design by which each leg cycles independently of the other (ie, the cranks are not fixed together). However, research examining the efficacy of training with uncoupled cranks is equivocal. The purpose of this study was to determine the effect of short-term training with uncoupled cranks on the performance-related variables economy of motion, gross efficiency, maximal oxygen uptake (VO_{2max}), and muscle-activation patterns. ***Methods:*** Sixteen trained cyclists were matched-paired into either an uncoupled-crank or a normal-crank training group. Both groups performed 5 wk of training on their assigned cranks. Before and after training, participants completed a graded exercise test using normal cranks. Expired gases were collected to determine economy of motion, gross efficiency, and VO_{2max}, while integrated electromyography (iEMG) was used to examine muscle-activation patterns of the vastus lateralis, biceps femoris, and gastrocnemius. ***Results:*** No significant changes between groups were observed for economy of motion, gross efficiency, VO_{2max}, or iEMG in the uncoupled- or normal-crank group. ***Conclusions:*** Five weeks of training with uncoupled cycling cranks had no effect on economy of motion, gross efficiency, muscle recruitment, or VO_{2max} compared with training on normal cranks.

Keywords: VO_{2max}, training, performance, iEMG, electromyography

During cycling, efficient transfer of energy to the pedals depends on how power, including direction and application of the force, is applied.[1] Typically, experienced cyclists apply most force to the pedal from the top (top dead center) to the bottom (bottom dead center) of the pedal stroke and reduce force application to the pedals during the recovery portion of the pedal stroke.[2] While such patterns of neuromuscular control allow high levels of force and power to be developed during knee extension, little force or power is produced during the upstroke of the pedal cycle. As such, it has been suggested that coordination between flexors and extensors, and therefore the efficiency of the pedal stroke, in trained cyclists may be less than optimal.[3]

Unlike normal cranks, uncoupled cranks use a clutch design that forces the cyclist to produce rotational force throughout 360° of the pedal stroke. Indeed, when cycling with uncoupled cranks the cyclist must pull up with each leg on every pedal stroke or the independent crank arm will simply remain at bottom dead center and rotational force will not be applied to the crank. It is claimed by enforcing 360° of force production the use of uncoupled cranks can train the hip and knee flexors to facilitate an alteration in neuromuscular recruitment (www.powercranks.com), thus improving the overall pedal-stroke efficiency.[4]

Only 3 studies[4–6] have examined the effects of cycle training with uncoupled cranks. Luttrell and Potteiger[4] compared 6 weeks of stationary-bicycle training with either uncoupled cranks or normal cranks (n = 6 per group, 3 d/wk, 1 h/d). They observed significantly lower heart rates and higher gross efficiency (~24% vs 21%) during the final 30 minutes of a 1-hour submaximal cycling test (completed on normal cranks) after training with uncoupled compared with normal cranks. Nevertheless, no differences after training were observed in maximal oxygen uptake (VO_{2max}) or ventilatory thresholds between groups. Williams et al[6] and Böhm et al[5] observed no improvement in VO_{2max},[6] peak power,[5] lactate threshold,[5,6] gross efficiency,[6] or average power output produced during a 30-minute time trial[6] after 5 to 6 weeks of training with uncoupled compared with normal cycling cranks. In the cited studies, participants

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were trained in laboratory conditions on stationary ergometers, a situation offering good study control but perhaps less ecological validity. Research suggests that when cycling in laboratory conditions, compared with road cycling, there is an alteration of the crank torque profile.[7] Furthermore, during cycling with uncoupled cranks the necessity to produce torque during the upward phase of the pedal stroke will limit the ability to use contralateral upper-body movement to counterbalance the high torque produced during the downward phase of the pedal cycle, especially at high power outputs. It is therefore believed that uncoupled cycling may enhance cycling efficiency, especially during laboratory-based cycling where the lateral movement of the ergometer is usually fixed. However, during field-based road cycling athletes may increase lateral movement of the bicycle (as seen during uphill cycling), thus reducing adaptations (ie, improvements in efficiency) expected during uncoupled cycling. Research examining the effect of using uncoupled cranks during a traditional outdoor training program is therefore needed.

In light of these equivocal findings on the effectiveness of training with uncoupled cranks in laboratory conditions, in addition to the lack of research performed in outdoor (field) conditions, the current study sought to determine whether outdoor training with uncoupled cranks would result in alterations to performance-related variables of gross efficiency, cycling economy, oxygen uptake, ventilatory thresholds, and muscle-activation patterns of the lower limb during cycling.

Methods

Participants

Sixteen trained male cyclists and triathletes were recruited to participate in this study (Table 1). All were required to have at least 3 years of cycling experience and a VO_{2max} >55 ml · kg^{-1} · min^{-1}. In addition, subjects were excluded from the study if they had any prior experience training with uncoupled cranks. Participants were asked to maintain a similar diet throughout the study. They were informed of all risks and benefits of their participation in this study, and their written informed consent was obtained before data collection. Ethical approval was obtained through the institution's human research ethics committee.

Design

This study used a matched-pair design, whereby participants were allocated into 1 of 2 groups matched for age, body mass, training load, and VO_{2max}. An equal number of cyclists and triathletes were represented in each group. Participants were instructed to complete 5 weeks of "regular" training during which 8 participants used traditional bicycle cranks and 8 used uncoupled cranks. Before and immediately after the 5-week training block, participants performed a graded exercise test (GXT), using standard cranks, in which VO_{2max}, the first and second ventilatory thresholds (VT_1 and VT_2), gross efficiency, economy of motion, and muscle activation of the lower limb were determined (described below).

Procedures

Before commencing training, participants in the normal-crank group were required to report to the laboratory on 2 separate occasions to perform a 15-minute familiarization cycling session and a GXT. Conversely, participants in the uncoupled-crank group were required to report to the laboratory on 4 separate occasions to perform a 15-minute familiarization cycling session, GXT, and 2 specific uncoupled-crank familiarization sessions (separated by 48 h). All performance tests were conducted on a magnetically braked cycle ergometer (Velotron Elite, RacerMate, Seattle, WA) equipped with normal crank arms. The length of the crank arm was set at 172.5 mm, and participants used their own pedals and cycling shoes for all sessions. At the end of each testing session, participants were asked 20 to 30 minutes posttest to assess the difficulty of their session on a rating of perceived exertion scale (session RPE).[8,9] They were tested in the 3-hour postabsorptive state to ensure that values of efficiency and economy were not influenced by diet.[10] During all sessions, participants were allowed to drink water ad libitum.

Table 1 Participant Characteristics, Mean ± SD

	Group	
	Normal crank, n = 8	Uncoupled crank, n = 8
Age (y)	33 ± 7.1	32 ± 7.8
Height (cm)	182 ± 7.0	176 ± 7.8
Body mass (kg)	77.4 ± 6.7	75.1 ± 6.1
VO_{2max} (ml · kg^{-1} · min^{-1})	57.2 ± 3.6	59.4 ± 3.7
Average distance cycled per week (km) in study	217 ± 66	204 ± 57
Average duration of cycling per week (h) in study	7.1 ± 2.7	6.8 ± 2.3

Note: There were no significant differences ($P < .05$) between groups in these variables.

GXT

The GXT commenced at a power output of 50 W for the first 4 minutes, and subsequent increases of 50 W occurred every 4 minutes thereafter. Throughout the test, participants cycled at a freely chosen cadence until volitional exhaustion or until they could not consistently maintain 60 revolutions/min. Oxygen uptake (VO_2), carbon dioxide production (VCO_2), and minute ventilation (V_E) were measured via a validated[11] ParvoMedics metabolic cart (ParvoMedics, Salt Lake City, UT). Before testing, the gas analyzers were calibrated using gases of known concentrations, while the flowmeter was calibrated using a Hans Ruldoph 3-L syringe over a range of flow rates. VO_2 was recorded at 15-second intervals, and VO_{2max} was determined as the highest 1-minute average. Ventilatory thresholds were determined using the methods of Lucia et al,[12] whereby VT_1 was defined as an increase in V_E/VO_2 without an increase in V_E/VCO_2, and VT_2 was defined as an increase in both V_E/VO_2 and V_E/VCO_2.

Peak power output (PPO) was recorded as the highest power output completed during the GXT and calculated in a pro rata manner using the following equation:

$$PPO = W_{com} + [(t/4) \times 50]$$

where W_{com} was the power corresponding to the highest stage completed and *t* refers to the amount of time (min) completed during the unfinished stage.[13]

Cycling economy of motion (EOM) was calculated using the average VO_2 measured over the last 2 minutes of the 200-W stage (during which respiratory-exchange ratio was <1.00) and applying the following formula[14]:

$$EOM\ (W/L) = \text{work rate}\ (W)/VO_2$$

Gross efficiency (GE) was determined by averaging the data collected over the last 2 minutes of the 200-W workload and applying the following formula[14]:

$$GE\ (\%) = [\text{work rate}\ (W)/\text{energy expended}\ (J/s)] \times 100\%$$

Energy expenditure (EE) was determined by the following formula[14]:

$$EE\ (J/s) = [(3.869 \times VO_2) + (1.195 \times VCO_2)] \times (4.186/60) \times 1000$$

RPEs were recorded at the completion of the 200-W stage using a 15-point (6–20) Borg scale.[8] Average heart rate during the final 2 minutes (recorded at 15-s intervals) of the 200-W stage was recorded for analysis (Polar Electro, Kempele, Finland).

Muscle Activation of the Lower Limb

Muscle activation of the lower limb was assessed via electromyography (EMG) and recorded on a data logger ME3000 (Mega Electronics Ltd, Kuopio, Finland). For the measurement of EMG, silver/silver chloride surface electrodes 20 mm in diameter were fixed to the belly of each of the 3 selected muscles of the left leg: vastus lateralis, biceps femoris, and gastrocnemius (medialis). Electrodes were placed 20 mm apart, with all being positioned and aligned as suggested by the European Recommendations for Surface EMG.[15] The selected muscles were chosen as they represent the predominant muscle used during typical cycling action (vastus lateralis) and 2 that may increase in activation as a result of the training intervention (biceps femoris and gastrocnemius). Preparation of the skin before electrode placement consisted of shaving the area, followed by light abrasion and wiping the area with an alcohol wipe. After this, electrodes were placed, and a reading of less than 5 kΩ achievable through skin impedance was deemed acceptable. Electrodes were held in place with adhesive tape (Fixomull) to ensure minimal movement throughout testing.[16] A digital electromagnetic switch was securely fitted to the bicycle frame at top dead center, and a magnetic sensor was fitted to the crank arm for EMG data standardization. The switch produced a digital signal (± 10 V) when the crank arm reached top dead center. EMG data were collected from the participant in the seated position for 10 seconds midway through the 200-W stage of the GXT. EMG data from 5 continuous crank revolutions was used to calculate the integrated EMG (iEMG). With the use of LabVIEW graphical development software (version 6.1; National Instruments Corp, Austin, TX), raw EMG data were full-wave rectified and passed through a high-pass fourth-order Butterworth filter (cutoff frequency of 15 Hz) to remove movement artifact. EMG data were then smoothed with a low-pass fourth-order Butterworth filter (cut-off frequency of 5 Hz) to produce a linear envelope.[16,17] An ensemble average was generated from the 5 crank revolutions taken from time-normalized data (0–1000 points for bottom dead center to bottom dead center—ie, on full crank revolution) to reduce within-participant variability. EMG data were amplitude-normalized using the maximal voluntary isometric contraction (MVIC), which was determined as the greatest value for an averaged 200-millisecond window of the linear envelope. The greatest EMG value for any of the 3 MVIC trials was used for normalization purposes. An iEMG value at each data point was taken as the average of all time-series values in the ensemble average.

Muscle-Function Testing

Before each GXT and for the purposes of EMG data normalization, the MVICs of the knee extensors, knee flexors, and plantar flexors were determined. Knee-flexor and -extensor strength were determined using a Biodex System 3 (Biodex Medical Systems, Inc, Shirley, NY). Before measurement, the participant's upper body was firmly strapped to the seat during testing while his left limb was attached to the arm of the dynamometer. After 2 warm-up attempts (replicating the action in the 3 maximal attempts but only at 50% and 75% effort), the participant was asked to perform three 5-second MVICs for knee extension (quadriceps) and knee flexion

(hamstrings), with 30 seconds rest between contractions. As adapted from previous studies,[18] strength measurements were taken at 60° for hamstrings and quadriceps, with the reference point being full extension. For MVIC of the plantar flexors, the participant was asked to sit in a calf-raise machine with the angle of the knee and ankle at 90°. The calf-raise machine was loaded with sufficient weight to ensure that participants performed an isometric contraction. The participant was then asked to perform three 5-second maximal contractions of the plantar flexors, with 30 seconds rest between contractions. Before isometric contractions, 2 muscle-girth measurements were taken with the use of a constant-tension tape measure. The first of these was the upper leg at the level of the placement of the rectus femoris electrode, and the second was the lower leg at the level of the placement of the gastrocnemius electrode.

Training

After completion of the GXT, participants were allocated to either the uncoupled-crank (UC) or normal-crank (NC) training group. The UC group started training 3 to 4 weeks before the NC group to ensure that both groups could be matched for total weekly training. Before the commencement of training, participants allocated to the UC group returned to the laboratory on separate days to complete 2 familiarization sessions. The first of these sessions consisted of three 5-minute work periods on the cranks separated by 5 minutes rest. The participants also received instruction on how to use the cranks during this time. The second session was completed on each participant's own bicycle and was conducted to ensure that the participants were comfortable cycling with the cranks and also during clipping in and out of their pedals.

After the familiarization sessions, the UC group began training using the uncoupled cranks. In this study, participants performed their regular training program in outdoor conditions for a period of 5 weeks using either uncoupled or normal cranks. To limit differences in training volume and intensity between the 2 groups, each UC-group cyclist was matched with an NC-group participant who cycled a similar weekly distance and had a similar fitness level (ie, VO_{2max}). In addition, the number of training hours of the UC and NC groups was matched by asking the NC participants to replicate the training hours of their matched UC-group participants. Training was matched in terms of total hours, rather than kilometers, as total kilometers were expected to drop while participants became accustomed to the new cranks. Weekly distance was determined for each matched NC-group participant based on a percentage of total kilometers or hours that the UC-group participant would complete in a regular training week (ie, when not participating in the current study). UC-group participants kept a training diary and were interviewed by phone or in person each week to discuss their progress. Using the pretraining study logs and subjects' perceptions, a percentage value was identified that approximated the percentage of their regular training that they completed that week. The NC-group participants' training was then altered, based on this percentage, to reflect their matched counterparts.

Statistical Analyses

The change in variables (ie, VO_2, VT_1, VT_2, PPO, economy, efficiency, iEMG, heart rate, and RPE), before and after training, was analyzed using a 2-way (group × time) repeated-measures ANOVA. To compare dependent measures within each group, significant main effects and interactions were analyzed using a 1-way ANOVA. Effect-size calculations, as per Rhea,[19] were also used to compare the magnitude of change in EOM and GE. These data were then given a magnitude derived from Rhea's table for determining the magnitude of treatment effects,[19] with participants classed as being recreationally trained (trivial < 0.35, small 0.35–0.80, moderate 0.80–1.50, large > 1.5). Statistical analyses were conducted using SPSS, Version 14.0 (Chicago, IL). The significance level was set at $P < .05$, and all data are presented as mean ± SD.

Results

GXT

Efficiency ($P = .012$) and economy ($P = .006$) were significantly different between groups before testing (see Figure 1). No differences in cycling economy ($P = .08$) and efficiency ($P = .09$) were observed between the pretraining and posttraining time points for the UC group. Moderate effect sizes for increases in both economy (ES = 0.93) and efficiency (ES = 0.90) were observed, resulting from uncoupled-crank training. In the NC group, economy (4% decline, $P = .01$) and efficiency (4% decline, $P = .03$) significantly decreased from pretraining to posttraining, with a large effect size observed for economy (ES = –1.59) and a moderate effect size observed for efficiency (ES = –1.36). This resulted in a significant interaction in both economy ($P = .01$) and efficiency ($P = .01$; see Figure 1) between the groups over pretraining and posttraining time points.

Data for VO_2, VT_1, VT_2, and PPO are displayed in Table 2. There were no observable differences between groups for VO_{2max} ($P = .39$) or PPO ($P = .99$). There were no differences in pretraining versus posttraining measurements of VO_{2max} or PPO observed for either the NC ($P = .42$ and $P = .94$, respectively) or UC ($P = .63$ and $P = .94$, respectively) group. Expressed as a percentage of maximum, no differences were observed from pretraining to posttraining for VO_2 at VT_1 ($P = .52$; $P = .71$) or at VT_2 ($P = .91$; $P = .51$) in the NC or UC group, respectively. There were no significant differences in these variables between groups (VT_1, $P = .79$; VT_2, $P = .67$).

Pedaling rate at 200 W was not different from pretraining to posttraining in either the NC (pretraining 96 ± 3 revolutions/min, posttraining 97 ± 2 revolutions/min; $P = .35$) or UC (pretraining 94 ± 7 revolutions/min, posttraining 90 ± 9 revolutions/min; $P = .31$) group.

Data for heart rate, RPE, and session RPE are displayed in Table 3. Heart rate and RPE responses were similar between groups at 200 W during the GXT. After training, there were no significant changes in heart rate at 200 W for either the NC (P = .89) or UC (P = .99) group. Likewise, there was no change in RPE at 200 W as a result of training (P = .87; P = .06) or for the session RPE (P = .51; P = .23) for either the NC or UC group.

Muscle Activation

Data for muscle activation are displayed in Table 4. No differences were observed in the iEMG of the vastus lateralis (P = .55, P = .61), biceps femoris (P = .58, P = .57), or gastrocnemius (P = .72, P = .21) from pretraining to posttraining for the NC or UC group, respectively. There were no significant differences in pretraining compared with posttraining measurements of upper-leg muscle girth for the NC (56 ± 1.5 vs 56 ± 1.8 cm, P = .84) or UC (56 ± 2.0 vs 56.3 ± 1.8 cm, P = .77) group. Similarly, no differences in lower-leg muscle girth for the NC (38.0 ± 2.2 vs 37.6 ± 2.1 cm, P = .68) or UC (36.8 ± 1.8 vs 36.9 ± 1.4 cm, P = .92) group were observed.

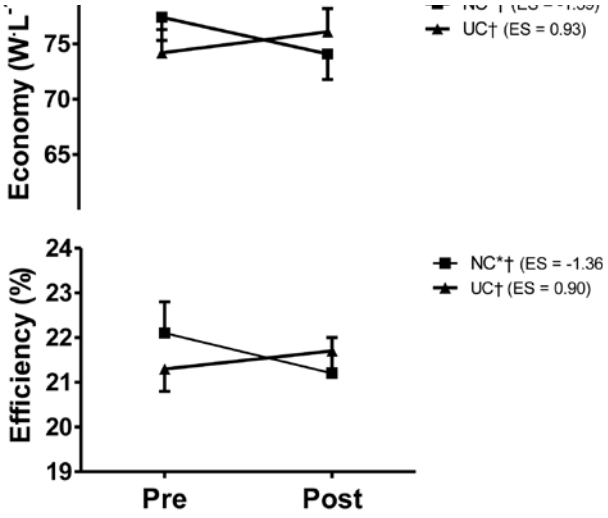

Figure 1 — Pretraining and posttraining values of gross efficiency and economy for the normal-crank (NC) and uncoupled-crank (UC) groups at 200 W during the graded exercise test, mean ± SD. *Significant pre to post; 1-way ANOVA, $P < .05$. †Significant treatment by time; 2-way ANOVA, $P < .05$. ES = effect size.

Discussion

The purpose of the current study was to examine the effect of 5 weeks of cycle training with uncoupled cranks on cycling economy and efficiency, PPO, VO_{2max}, and lower-body muscle activation. The main findings from this study were that training with uncoupled cranks did not alter cycling economy during a GXT with normal cranks (although it did produce a moderate effect size); training with uncoupled cranks did not influence VO_{2max}, ventilatory thresholds (VT_1 and VT_2), or PPO measured during a GXT; and no differences in muscle activation were observed pretraining to posttraining in either the normal- or uncoupled-crank group.

The use of uncoupled cranks is suggested to enhance cycling technique, which should therefore be measurable by an increase in cycling economy.[4] Nevertheless, in our participants, no statistically significant differences in cycling economy or efficiency were observed after 5 weeks of training with uncoupled cranks. Our findings are consistent with those of Williams et al,[6] who observed no change in the gross efficiency or average power maintained during a 30-minute cycling time trial performed by well-trained cyclists (VO_{2max} 60.6 ± 5.5 ml · kg^{-1} · min^{-1}) after a 6-week training intervention. Conversely, after their subjects undertook 6 weeks of training on uncoupled cranks, Luttrell and Potteiger[4] observed a significant increase in gross efficiency at 45 and 60 minutes of a 60-minute submaximal cycling trial performed at the power output corresponding to 69% of cyclists' pretraining VO_{2max}. The inconsistency between our findings and those of Luttrell and Potteiger[4] is possibly due to the difference in fitness level (VO_{2max} 54.2± 7.3 ml · kg^{-1} · min^{-1}

Table 2 Pretraining and Posttraining Maximal Oxygen Uptake (VO_{2max}), Peak Power Output, and the First (VT_1) and Second (VT_2) Ventilatory Thresholds at 200 W During the Graded Exercise Test, Mean ± SD

	Group			
	Normal crank		Uncoupled crank	
	Pre	Post	Pre	Post
VO_{2max} (ml · kg^{-1} · min^{-1})	57.2 ± 3.6	58.6 ± 3.1	59.4 ± 3.7	58.3 ± 5.8
Peak power output (W)	372 ± 31	371 ± 35	370 ± 26	369 ± 34
VT_1 (%VO_{2max})	64 ± 8	61 ± 10	63 ± 5	62 ± 6
VT_2 (%VO_{2max})	82 ± 8	83 ± 9	87 ± 5	85 ± 5

Note: No differences between groups or over time.

Table 3 Pretraining and Posttraining Heart Rate and Rating of Perceived Exertion (RPE) at 200 W and Session RPE for the Graded Exercise Test, Mean ± SD

	Group			
	Normal crank		Uncoupled crank	
	Pre	Post	Pre	Post
Heart rate	140 ± 13	141 ± 8	143 ± 15	143 ± 16
RPE	10 ± 1	10 ± 2	10 ± 2	12 ± 1
Session RPE	17 ± 3	16 ± 2	15 ± 1	16 ± 2

Table 4 Pretraining (Pre) and Posttraining (Post) Activation at 200 W During the Graded Exercise Test, Mean ± SD

	Group			
	Normal crank		Uncoupled crank	
iEMG Placement	Pre	Post	Pre	Post
VL (%MVIC)	11.3 ± 3.3	12.5 ± 3.8	11.6 ± 2.7	12.7 ± 5.8
BF (%MVIC)	9.9 ± 4.8	11.0 ± 3.1	10.8 ± 6.1	9.4 ± 3.4
GAS (%MVIC)	23.1 ± 10.1	21.4 ± 7.7	26.5 ± 7.6	21.8 ± 6.3

Abbreviations: iEMG, integrated electromyography; VL, vastus lateralis; MVIC, maximum voluntary isometric contraction; BF, biceps femoris; GAS, gastrocnemius.

compared with 58.3 ± 3.6 ml · kg^{-1} · min^{-1} in the current study) of participants in the studies. In addition, the principal of specificity states that in order to provoke adequate physiological adaptations, specific tasks need to be completed under specific conditions.[20] Therefore, it is possible that the findings of Luttrell and Potteiger[4] were a result of completing both training and testing in a laboratory setting. In the current study, the training was completed on each participant's own bicycle, with only testing completed in the laboratory.

Cycling performance cannot be determined by a single physiological factor such as cycling economy.[2] While cycling performance was not directly assessed in this study, we examined the effect of training with uncoupled cranks on VO_{2max}, ventilatory thresholds, and PPO, all of which have been correlated with cycling time-trial performance.[2] Our findings indicate that 5 weeks of training with uncoupled cranks does not increase VO_{2max}, ventilatory thresholds, or PPO (see Table 2). Similarly, Luttrell and Potteiger[4] observed no change in VO_{2max} or ventilatory threshold (as measured by the V-slope method), while Böhm et al[5] measured no difference in peak power and power output at ventilatory threshold after training with uncoupled cranks. Together, these findings indicate that training with uncoupled cranks for a period of 5 to 6 weeks does not result in significant improvements in VO_{2max}-related variables in already-trained cyclists. Further research examining the influence of uncoupled cycling training on cycling performance is warranted.

The inability to measure a significant physiological change in our participants after training with uncoupled cranks does not definitively indicate an absence of neuromuscular adaptation.[21–25] Nevertheless, in the current study neuromuscular amplitude patterns were not found to be significantly altered after 5 weeks of training with uncoupled cranks. We do not feel that these findings have been influenced by the duration of training, as Creer et al[22] demonstrated in a group of 17 trained cyclists that 4 weeks of sprint cycle training (carried out biweekly comprising a total of 28 min of the training period) was sufficient to increase motor-unit amplitude, suggesting that the 5-week training block used in the current study could have elicited a response in this variable. However, this was not the case, which indicates that the uncoupled cranks do not change activation patterns when cyclists return to using regular cranks. Further research is warranted to determine the influence of uncoupled-crank cycle training on neuromuscular patterns of lower-limb muscles not measured in this study.

It is unclear why cycling economy and efficiency in the NC group (that resulted in a significant group interaction over time) decreased after training. It could be that because the NC subjects were carrying out a reduced amount of training, to match their UC-group counterparts, their overall training quality could have dropped, causing a subsequent drop in efficiency. In addition, due to the fact that the NC group started their training at least 3 weeks after the UC group, they were exposed to more wintery

weather, which could have resulted in a reduced quality of training due to the higher frequency of inclement-weather days more commonly experienced during this period. Nevertheless, the total cycle-training distance and time spent cycling were the same for both groups, leaving explanations for this reduction in economy and efficiency unclear.

One of the main limitations of the current study was that it only examined the initial adaptations to training with uncoupled cranks over a 5-week period. Indeed, this device has not been extensively studied thus far, and further research is needed to determine if uncoupled cranks do provide a benefit over a longer training period. In addition, while we measured variables associated with performance,[2] we did not directly measure performance. For this reason, we cannot conclude that the use of uncoupled cranks does not provide a performance benefit. Nevertheless, results from the current study indicate that 5 weeks of training using uncoupled cranks did not enhance neuromuscular and physiological factors associated with cycling performance. Such results do not support an improvement in hip- and knee-flexor muscles to facilitate an alteration in neuromuscular recruitment, thus improving the overall pedal-stroke efficiency, as claimed by uncoupled-crank manufacturers. However, further research is needed to examine the influence of training with uncoupled cranks on various physiological variables and to examine the implications of training with uncoupled cranks over a longer training period, possibly with longer, more frequent, or more intense training sessions.

Practical Applications

Previous research has shown benefits in cycling performance and related variables when training indoors with uncoupled cranks.[4] The results of the current study, however, indicate that 5 weeks of field training with uncoupled cranks elicited no significant advantage compared with training on normal cranks. Therefore, there appears to be no significant advantage to training outdoors on uncoupled cranks compared with training on regular cranks over a period of 5 weeks. It should be noted, however, that no significant negative effects were observed after 5 weeks of training on uncoupled cranks. Therefore, uncoupled cranks may offer coaches an alternative training option or rehabilitation method (to target interleg deficiencies).

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