up to
900
watts

ECCENTRIC CYCLE TRAINING

Elevates the quadriceps strength and volume

CYCLUS 2
ECCENTRIC

Eccentric cycle ergometry:

An old concept turned into a novel training modality

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In concentric (CON) muscle work, the muscle shortens during activation and exerts motor actions, whereas in eccentric (ECC) muscle work, the muscle undergoes a forced lengthening while bearing an external load and exerts braking actions. The last 15 years have seen a renewed interest for ECC cycle ergometry.

The very first ECC cycle ergometer for the lower limbs was described by Abbott et al.[1, 2] (Fig. 1) and was subsequently adapted as new technologies became available for both lower[3, 4] and upper limbs. 5 Very recently, an eccentric cycle ergometer has been made commercially available offering now the possibility to use a normal bike to generate ECC muscle work (Cyclus2 Eccentric Trainer©).

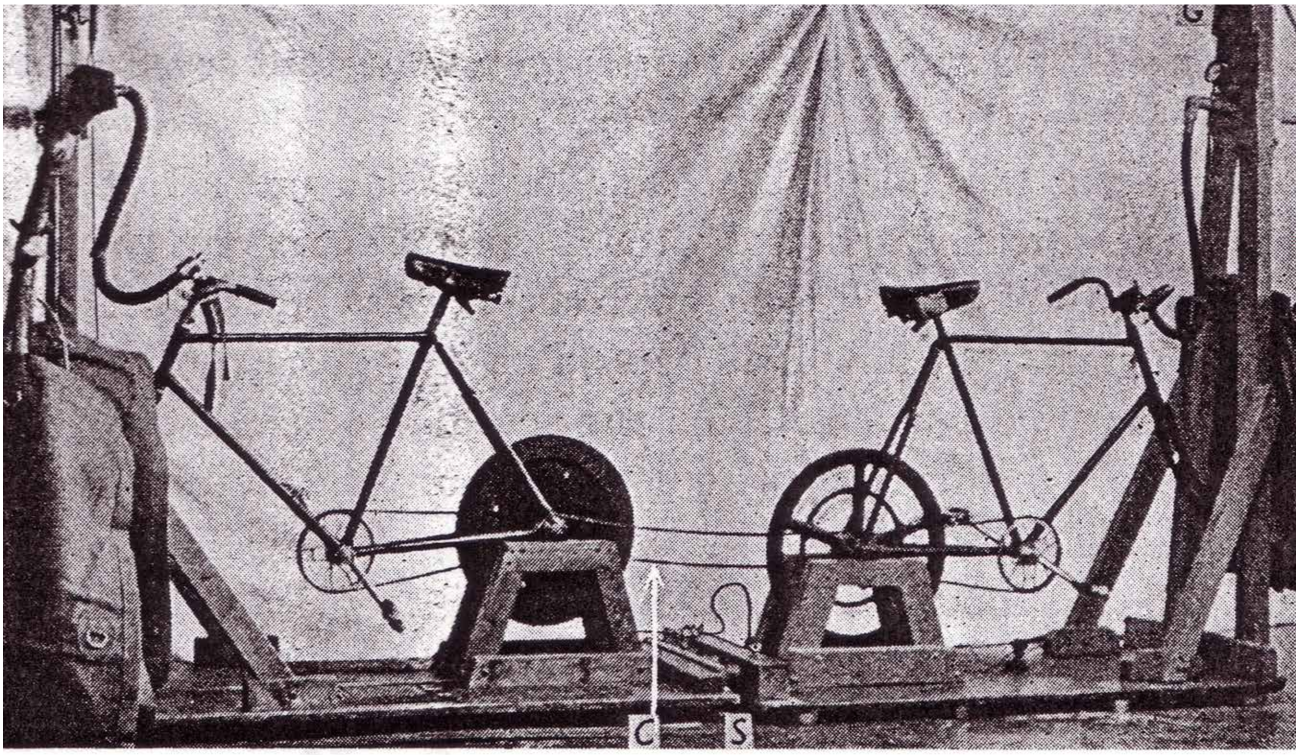

Figure 1: The first eccentric cycle ergometer. Two bicycle ergometers were placed back to back and coupled by a chain; when one cyclist pedaled concentrically in the conventional forward direction, the legs of the other cyclist were driven backwards, generating eccentric muscle work (reproduced from Abbott et al.[1])

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1. Major physiological properties of eccentric muscle work

ECC muscle actions can produce greater force than CON or isometric muscle actions.[6-8] The greater force produced during ECC muscle actions arise from a combination of specific, although not yet fully identified, molecular events involved in the cross-bridge cycle[9] and of specific neural control strategies[10]. At similar mechanical power output, ECC cycling elicits a lower oxygen consumption (VO_2)[5, 11], and reduced ventilatory[12] and cardiocirculatory responses (Figure 2).[13, 14]

The lower oxygen cost of ECC cycling might be due to a combination of non-adenosine triphosphate (ATP)-dependent "mechanical" rupture of the actin-myosin cross-bridges [15, 16], greater distance covered by each individual actin-myosin crossbridge[17, 18] and lower recruitment of motor units.

Therefore, the general feeling of subjects cycling eccentrically is that exercise is much easier compared to the CON cycling, as attested by lower levels of perceived exertion. Also of particular interest are several reports which suggest that despite being "energy efficient", ECC cycling might increase post-exercise resting energy expenditure for up to 72 h[19-21].

ECC cycling can also be performed at a similar VO_2 as CON cycling provided that the mechanical power output in the ECC mode is large enough (i.e., 5-fold higher in ECC than CON cycling). In this specific condition, Q and HR are higher during ECC cycling.

This observation has important repercussions for the management of exercise intensity and training load as exercising at a similar VO_2 actually requires a higher HR in ECC than in CON cycling.[5]

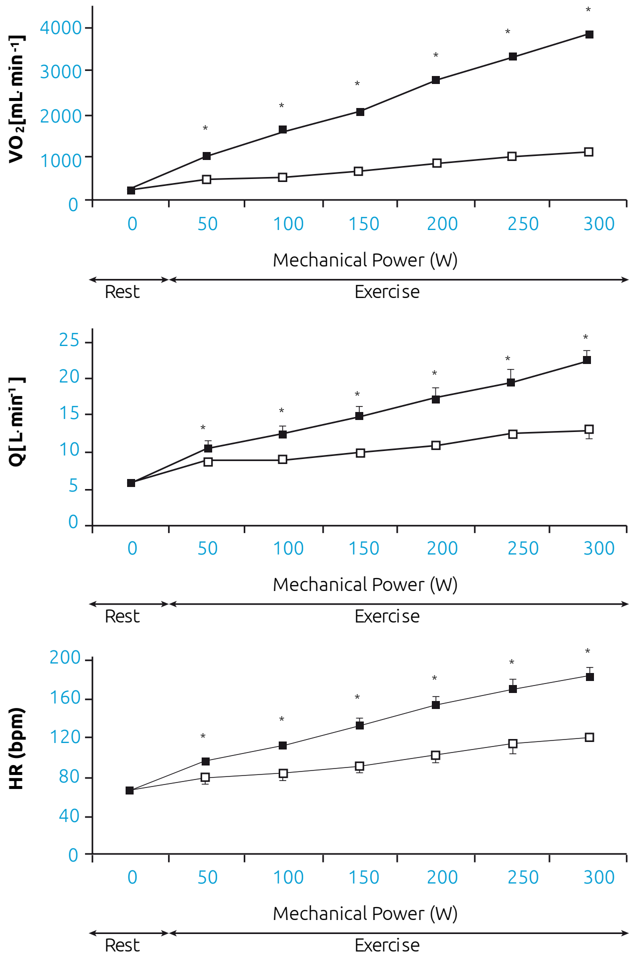

Figure 2: VO_2, Q and HR as a function of the mechanical power during CON and ECC cycling. (adapted from Dufour et al. [5]). CON: black symbols; ECC: open symbols, $p < 0.05$: significant difference CON vs ECC.

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2. Eccentric cycle exercise do not necessarily generate muscle damage

ECC muscle work can lead to marked exercise-induced muscle damage (EIMD), especially when high muscle forces are generated[22-24] and/or if the ECC muscle actions are performed at high velocity[25] or short muscle length.[26]

However, the magnitude of EIMD is progressively reduced after repetition of the same ECC exercise; (i.e repeated bout effect)[22, 24, 27] and subjects engaged in regular ECC training become less susceptible to EIMD[28-30].

Therefore, if ECC cycling intensity is increased gradually, both young[31, 32] and older[33, 34] healthy subjects can adapt to high-force ECC exercises without muscle damage and with positive training induced adaptations.

3. Training Response After ECC Exercise Training Programmes

A major advantage of ECC cycling is the possibility to achieve very high mechanical load (up to 900W over 30min continuous training session[35]) with limited energy expenditure. ECC cycling as a training strategy was shown to improve isometric strength (+33 %) and induce greater hypertrophy of the quadriceps muscle (+52%) than CON cycling training in healthy subjects. In high-school basketball players and top level junior alpine skiers, ECC cycle training improved jump height by 6-8% compared with weight-training.[36]

Increased jumping power and leg spring stiffness were also documented after ECC compared to CON cycle training,[37] suggesting that ECC cycle training might improve muscle ability to store and restore elastic strain energy. The interest of ECC cycling is also appearing for rehabilitation purposes in athletes as elevated quadriceps strength and volume were observed after ECC compared to CON cycle training after ligamentoplasty of the anterior cruciate ligaments of the knee.[38, 39] In elderly people[33] or in patients suffering from cardiorespiratory diseases, metabolic disorders[3], neurological pathologies40 and some types of cancers (i.e breast, prostate, lung, colon and lymphoma)[4, 41], ECC cycle training demonstrated its feasibility even at very advanced age (i.e >80 yr old) with virtually no EIMD nor other side effects. Common to these differents conditions, ECC cycle training has demonstrated encouraging results in increasing muscle mass and force ultimately improving exercise capacity and quality of life. Altogether, these findings suggest that ECC training might be particularly suitable for improving body composition and muscle strength even in the more frail subjects, possibly via the specific expression of transcripts encoding factors involved in muscle growth, repair and remodeling.[42]

Although its specific mechanical, metabolic and cardiovascular responses deserve particular attention for optimal monitoring of training load, ECC cycle ergometry currently emerges as a promising training strategy not only for athletes but also in the elderly and many diseased states.

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Cyclus2 Eccentric Trainer

Operation modes:	
Load types:	■ isokinetic (cadence) ■ power controlled (Watt) ■ torque controlled (Nm)
Controls:	■ manual ■ program controlled
Maximal power:	■ 900 Watt (short-term)
Compatibility:	
Clamping back:	■ Sprocket 12T 1/2 x 1/8 inch, no free wheel, mounting 120 mm, for special eccentric bike frames
Clamping front:	■ quick release 9 mm x 100 mm
Axial distance:	■ min. 80 cm, max. 119 cm (different distances on request)
Heart rate sensor:	■ ANT+ heart rate transmitters (e. g. Garmin)
Accessories (optional):	
Bike frame:	■ matching frames of track or touring bikes of different sizes
Heart rate sensor:	■ ANT+ heart rate transmitter incl. wear belt
Floor cover:	■ Floor mat
Accuracy, Calibration:	
Power:	■ maximal error 4% of reading (for power values less than 100 Watt maximal 4 Watt)
Cadence:	■ error maximal ± 1 RPM
Calibration:	■ dynamic calibration, incl. Calibration protocol, recommended on a yearly basis
Mechanical feedback:	■ HBM T5 torque flange (accuracy class 0, 1)
Interfaces:	
2 x USB:	■ for USB-stick, printer or external keyboard
1 x LAN:	■ 100/10MBit Ethernet for remote control via VNC, network printer
1 x WLAN:	■ optional, 802.11g/ 2.4/5 GHz WiFi, for remote control via VNC, network printer
Printer driver:	■ PCL3, PCL5 compatible (e.g. HP Officejet H470, HP Officejet 100) PDF, TIFF
Data export:	■ user-defined CSV-format
General information:	
Languages:	■ German, English, French, Italian, Polish, Russian, Spanish, Portuguese
Voltage supply:	
Power input:	■ 1000 Watt (maximum)
Power adaptor:	■ wall power supply 100-240 V AC/ 50-60 Hz, output voltage 12 V DC / 2,08 A, medical registration according to IEC 60601-1:2005 (3rd Edition) ■ desk power supply 100-240 V AC/ 50-60 Hz, output voltage 24 V DC / 40 A, medical registration according to EN/UL 60601-1, inclusive emergency stop button
Dimensions, Weight:	
Assembly dimensions:	■ approx. 140 x 50 x 105 cm (L x B x H) depending on the type of bike used
Weight:	■ approx. 30 kg (exclusive Bike)

Safety instruction:

Please note that the Cyclus2 eccentric ergometer is only permitted to use in the presence of specifically trained staff. In case of any irregularities, this staff has to be able to promptly switch off the ergometer using the emergency stop button.

Technical details and colours may vary from those shown in the picture.

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