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Caution Needed When Interpreting Muscle Activity Patterns During Extremely Low Pedaling Cadence

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Letter to the editor

Caution needed when interpreting muscle activity patterns during extremely low pedaling cadence

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Dear editor,

We noticed recent research that has just been published in *Journal of Sport and Health Science (JSHS)*, comparing the muscular activity patterns in 1- and 2-legged cycling by Park and Caldwell.[1] The authors reported that changes in muscle activities with 1-legged pedaling are due to a variety of changes in mechanical aspects of the pedaling motion, including altered crank torque patterns within the crank cycle, decreased pelvis stability, and the need for increased knee and ankle stiffness during the upstroke. The experiment was well-designed and the discussion was fascinating. However, the testing protocol does not support the significance of the project, as stated in the first sentence of the abstract, *"One-legged pedaling is of interest to elite cyclists and clinicians."* Their testing was conducted at 30 revolutions per min (rpm) and 30 watts (W), and both are too low for any kind of mechanical demand for cycling, either competitive sports or rehabilitation. The preferred cadences of experienced cyclists are approximately 85−95 rpm, whereas the most economic cadences are approximately 55−60 rpm.[2] The choice of low cadence has been attributed to avoiding muscle fatigue in the participants, but previous studies have approved the possible proper cadence of 1-legged pedaling ranges from 50 rpm to 90 rpm.[3−6] Even for post-stroke individuals, the cadence of 40 rpm has been used.[7]

More important, there is plenty of evidence shown that muscle activities and neuromuscular coordination during cycling are significantly influenced by pedaling cadence. The lower extremity joint moment distribution would dramatically change when the pedal frequency was changed.[8−10] Greater pedaling cadence resulted in reduced patellofemoral compressive force with no effect on the tibiofemoral joint forces.[8] The average relative contributions of the knee joint musculature were decreased, while those of the hip were increased as cadences increased.[9] It has also been reported that with variations in power output and cadence, the relative contribution of the moments at the ankle, knee, and hip joints remains relatively invariant.[10] Leirdal and Ettema[11] measured gross efficiency and force effectiveness with 10 well-trained cyclists cycling at 3 different freely chosen cadences. The pedaling cadences investigated ranged from 86 rpm to 106 rpm. Cadence has a strong negative and similar effect on both force effectiveness and gross efficiency. Gross efficiency indicates the total metabolic rate, including muscle power output, for a given external power output, and force effectiveness is the resultant outcome of all muscle activation.[11]

Some studies using electromyography (EMG) analyzed cadence effects on muscular activity. Marsh and Martin[12] observed significant muscle activity changes with cadence. They reported significant timing differences with different cadences in the vastus lateralis (VL), the rectus femoris (RF), the biceps femoris (BF), gastrocnemius, and soleus muscles. Peak muscle activity occurred earlier in the crank cycle as cadence increased from 50 rpm to 110 rpm for each of the muscles except the RF. Additionally, increasing pedaling speeds have elicited double bursting patterns in some bi-articular muscles.[13] Baum and Li[14] investigated the effects of frequency and inertia on lower extremity muscle activities during cycling. Sixteen subjects cycled at 250 W across different cadences (60 rpm, 80 rpm, and 100 rpm) with different external loads. Load and cadence interactions were observed for the offset of BF, the active duration of RF, and the peak magnitudes of VL and the tibialis anterior. Cadence effects were observed in the onset of the gluteus maximus, RF, BF, VL, and tibialis anterior; the offset of the gluteus maximus, RF, BF, VL; the duration of the BF and tibialis anterior; the peak magnitude of the RF and gastrocnemius; and the crank angle

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at which the peak magnitude was achieved of the BF, gastrocnemius, and soleus. Obvious differences can be observed comparing the EMG activities of 2-legged pedaling reported in this article[1] with some of the EMG patterns reported in the literature, such as Marsh and Martin[12] and Baum and Li.[14] For example, the peak RF EMG activity reported right before reaching the top-dead-center here was not observed in either of the earlier reports. For another example, BF EMG peaked at about the bottom-dead-center here, at least 50° of crank angle later than what has been seen in earlier reports.

In summary, the effects of pedaling cadence on muscle activities have been reported. Cadence had greater effects proximally than distally for onset timing, offset timing, and some antagonist pair coordination in the lower extremity. Thus, the results of this paper should be extrapolated carefully. A proper choice of cadence should be considered if the intent was to find meaningful applications to competitive sports and clinical demands.

Authors' contributions

Both authors contributed to the letter fully. Both authors have read and approved the final version of the letter, and agreed with the order of presentation of the authors.

Competing interests

Both authors declare that they have no competing interests.

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