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Acute effects of small changes in crank length on gross efficiency and pedalling technique during submaximal cycling

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Abstract

Background: To the best of our knowledge, only four experimental studies analysed the influence of the crank length in the efficiency of energy consumption. No significant differences were found on metabolic cost while pedalling with crank lengths between 145 and 200 mm. None of these studies took into account changes in pedalling technique (kinetic and kinematic profile), which might affect both the efficiency of energy consumption and the muscular activity profile of the lower limb (Astrand, 1953: Arbeitsphysiologie, 15, 23-32; Klimt & Voigt, 1974: European Journal of Applied Physiology, 33, 315-326; Morris & Londeree, 1997: Canadian Journal of Applied Physiology, 22, 429-438; McDaniel et al, 2002: Journal of Applied Physiology, 93, 823-828).

Purpose: The main purpose of this study was to assess the acute effects of small changes in crank length assumable by competitive cyclists (±5 mm) on metabolic cost and pedalling technique during submaximal cycling.

Methods: Twelve well-trained road cyclists with a minimum of two years competing in cycling and training more than 3000 km participated in the study. They performed in a randomized order three sets of submaximal pedalling (150, 200 & 250W) at a constant cadence (90 rpm) using three commonly used crank lengths (preferred, +5 mm and -5 mm). Simultaneous physiological (oxygen uptake, respiratory exchange ratio, heart rate and gross efficiency) and biomechanical analyses of pedalling were performed (sagittal hip, knee and ankle angles obtained by 2D high-speed video; and torque exerted on the left and right cranks independently every 2º of a complete revolution). Two-way ANOVA with repeated measures was used to analyse the effect of the crank length and power output on biomechanical and physiological variables.

Results: Non-significant effects of crank length on oxygen uptake, RER, heart rate and gross efficiency were found ($p>0.05$). There was a significant effect ($p<0.001$) of the crank length on maximum torque (longest cranks increased it between 1.0-2.3 N·m), minimum torque (longest cranks increased it between 1.0-2.2 N·m) and MFE (longest cranks decreased it between 1 0.9-1.9%). Longest cranks also increased ($p<0.05$) the flexion and range of motion of the hip (0.9-2.5°) and the knee (1.3-3.4°), whereas ankle joint was not affected. No significant effect crank length × pedalling power output was found.

Discussion: The main outcome of this study was that small changes in crank length at submaximal intensity and at constant cadence did not produce significant changes on the efficiency of energy consumption whereas significant changes on biomechanical variables (kinetics and kinematics) were produced. A longer crank decreased the MFE due to a greater minimum torque during the upstroke. Moreover, the flexion and the range of motion of the hip and the knee increased while ankle joint was not affected.

Conclusions: In conclusion, kinematic and kinetic changes due to a longer crank were not significant enough to alter the efficiency of energy consumption, although future studies should investigate their long term effects on muscle coordinative pattern in distance events and on overuse injuries.

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