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The Influence of Hip and Knee Angle and Body Position on Power Which can be Achieved During Cycle Ergometry

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Abstract:

Introduction: The foundation of animal movement is application of linear muscle forces to skeletal lever systems, and conversion of linear forces to joint torque. Torque is influenced by muscle force, angle of muscle pull on bone, and length of the force lever. As joints move through the range of motion, the angle of muscle pull on bone changes, so joint position affects the magnitude of force applied to the external environment.

Methods: Force/strength determines how much weight can be moved, and muscular power (the product of force and speed) determines rates of work and acceleration. Power is the more important mechanical/energetic aspect of successful performance in team and individual sports, and various types of racing. These principles are particularly applicable to cycling, in which a complex system of levers act as an extension of the human body. Experienced cyclists intuitively learn to alter their postures and associated joint angles to more effectively climb hills, accelerate, and overcome other challenges. Standing out of the saddle is universally employed by experienced cyclist to produce greater power, and two theories about how standing results in greater power have been proposed; standing allows full body weight to be applied to the pedal; standing evokes more obtuse angles at the hip and knee, and muscle forces are applied to the skeleton at more favorable angles, resulting in greater joint torque.

Results: Related to these principles, the objective of the current research was to measure external power produced during cycling, and compare power produced during four postures/conditions differing in joint angles at the hip and knee and amounts of "body weight" applied to the pedal. Data have been collected from ten young fit male volunteers with experience in cycling and strenuous exercise, who provided informed consent. After 2 familiarization sessions, two testing sessions involving multiple (8 per session) bouts of short, high intensity pedaling on a cycle ergometer were conducted. The resistances employed have been previously shown to evoke peak power during this type of cycling. Power was assessed and compared under 4 conditions: seated pedaling with the seat set at an

established standard height;, seated pedaling with seat height 20% lower; standing pedaling; and standing pedaling while wearing a weight vest equal to 20% of lean body mass. The order of the conditions was randomized, and two conditions were tested per session. Subjects were video-taped in the sagittal plane, and the video was analyzed to measure and compare knee and hip angles in the 4 conditions.

Conclusion: Results reveal that greatest power was produced standing with the weight vest (mean = 1058 Watts), second greatest during standing (mean = 1056 Watts), third greatest while sitting at normal seat height (mean = 1007 Watts) and least during the low seat condition (mean = 864 Watts. The research supports the untested theory that more pedaling power can be generated while standing because the full body weight is applied to the pedals, and also suggests that more obtuse knee and hip angles contribute to greater power output.