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EFFECTS OF DORSIFLEXION ON ENERGY EXPENDITURE DURING CROSS-COUNTRY SKIING USING THE V1 SKATE TECHNIQUE

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INTRODUCTION: Competitive cross-country skiing involves race events of different distances conducted over natural terrain. The primary objective of the skier is to cover the race distance as quickly as possible. This requires the athlete to achieve a high speed to energy expenditure ratio while maintaining physiological strain within tolerable limits. Thus, the influence of various mechanical techniques of skiing on energy expenditure and physiological strain is of interest to skiers.
There has been interest concerning the possible effects of various joint angles on skiing techniques (Smith, 1992). More specifically, ankle flexion seems to play some role in reducing the abovementioned speed to energy expenditure ratio. An increase in dorsiflexion may be reflective of a more forward center of mass position and a degree of force oriented downward and rearward onto the ski. A portion of this force may be propulsive. As a result, increased dorsiflexion may provide lower oxygen demands for a given velocity of movement.
The purpose of this study was to examine whether oxygen uptake and energy expenditure vary with different degrees of ankle dorsiflexion during the V1 skating technique. A second objective was to determine if a degree exists where dorsiflexion does not influence energy expenditure during the V1 skating technique.

METHODS: Twenty collegiate competitive cross-country skiers volunteered and signed Informed Consent to participate as subjects. Each subject completed three steady-state bouts of treadmill rollerskiing at 10 $km \cdot hr^{-1}$ on 5, 7 and 10% grades using the V1 skating technique. The V1 skating technique is typically used for climbing moderate to steep terrain during freestyle racing. An oversized treadmill (1.5 m x 2.5 m) enabled subjects to rollerski with poles without constraining the technique.
Expired air was analyzed continuously during each bout of skiing via a SensorMedics VMax29c breath-by-breath metabolic analysis system. Oxygen uptake, respiratory exchange ratio, and energy expenditure were determined via the instrument's software.
Video of the roller skiing exercise was obtained at 60 Hz via three synchronized Sony Optura 20 digital cameras positioned in front, behind and on the left side of the subject. Reflective markers were placed on the knee joint center, the lateral malleolus and the fifth metatarsal to allow for determination of ankle dorsiflexion angle. Markers were digitized and smoothed using a fourth order Butterworth filter (Winter, 1990) via Peak Motus™ 8.2. Video and spirometric data were synchronized via a signal that started the data collection phase of the metabolic system and simultaneously inserted a marker into the digital file of the synchronized cameras. Expired air analysis and video data were subsequently combined into a single file and splined to create a file of equal length. The relationship between oxygen uptake and energy expenditure versus ankle dorsiflexion was tested via correlation analysis.

DISCUSSION: This is a work in progress. Data collection will continue through April and May of 2005. Initial results should be available for the ISBS Conference in August of 2005. Preliminary data indicate that increased dorsiflexion is associated with lower energy expenditures during steady-state V1 rollerskiing.

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