EFFECTS OF STEP LENGTH ON THE BIOMECHANICS OF LOWER LIMBS DURING ELLIPTICAL EXERCISE

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INTRODUCTION: Elliptical exercise (EE) has been developed as a low-impact aerobic exercise modality with increased popularity in fitness training and clinical applications over the last decade. During EE, the feet are constrained by pedals to follow an elliptical trajectory, with the possibility of producing disadvantageous joint loads and potential musculoskeletal overuse injuries (Lu et al., 2007). Therefore, proper selection of step length during EE may be helpful for the reduction of these disadvantageous joint loads. The purpose of the study was to study the effects of three different step lengths on biomechanics of the lower limbs during EE.

METHODS: Fifteen healthy male adults (23.7 ± 1.2 yr; 173.5 ± 3.9 cm; 72.2 ± 10.8 kg) performed EE on an elliptical trainer at three step lengths (55%, 60% and 65% leg length or LL), with a pedal rate close to their corresponding walking cadence and without workload. Three-dimensional kinematic data of the whole body and pedal reaction forces (PRF) were measured using a 7-camera motion capture system (Vicon 512) at a sampling rate of 120Hz and a six-component force transducer at a sampling rate of 1080Hz. Repeated measures analysis of variance was used to test the effects of step length on the peak excursion of the whole body center of mass (COM), PRF, joint angles and moments. The significance level was set at 0.05.

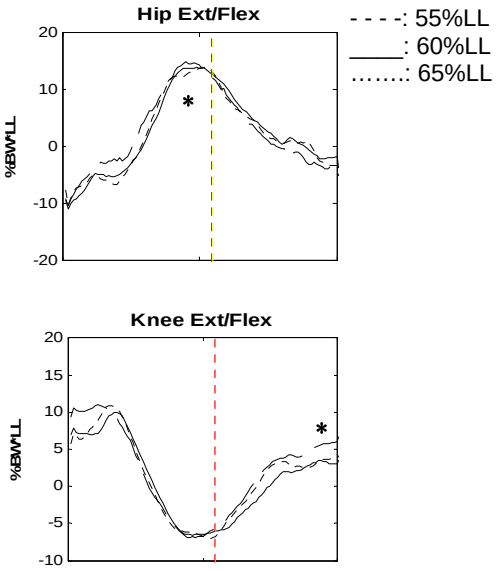

Fig1: Hip and knee ioint moments at three step lengths. (∗: p<0.05)

RESULTS and DISCUSSION: When the step length increased, significantly greater vertical motion of COM and increased vertical PRF were found during a period corresponding to the early stance of gait ($p<0.05$) while decreased ankle dorsiflexion and knee flexion were found at initial contact. Peak hip extensor moment at late stance and peak hip abductor moment at early stance increased as the step length increased, whereas the knee extensor moment at late swing decreased (Fig. 1). In the current results, subjects appeared to use the strategy of decreasing the ankle dorsiflexion and knee flexion to increase the length of lower limb for compensating for the changed pedal trajectory with increasing step length, and then altered joint kinematics further resulted in the observed greater vertical motion of COM. With greater vertical PRF, more flexed ankle and knee joints shifted the lines of action of the PRF to pass away from the hip joint center, leading to increased hip joint moments. Therefore, EE training should be used with smaller step length, preferably less then 55% LL, for patients with hip degeneration or pathologies.

CONCLUSION: This study showed that during EE increase of step length may increase harmful joint loadings, especially at the hip joint. The use of elliptical trainers for athletic and rehabilitative training should select appropriate pedal position and step length considering the user's joint function and muscle strength to avoid the potential risk of injury.

REFERENCES: Lu, T.-W. , Chien, H.-L. and Chen, H.-L. (2007) Joint loadings in the lower extremities during elliptical exercise, *Medicine & Science in Sports & Exercise.* 39:1651-1658.