

## DO KINEMATICS OF THE PELVIS AND LOWER LIMB VARY BETWEEN NOVICE AND HIGHLY TRAINED CYCLISTS?

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### INTRODUCTION

Previous studies have shown that novice and highly trained cyclists use different patterns of leg muscle recruitment when cycling [1, 2]. Novice cyclists are characterized by greater individual variance, greater population variance, longer durations of muscle activity, more extensive and more variable muscle coactivation, and less modulation of muscle activity. The data also show that modulation of muscle activity decreases with increasing cadence in novice cyclists but is not influenced by cadence in highly trained cyclists. However, kinematics were not controlled in these studies of cycling so differences in leg muscle recruitment between novice and highly trained cyclists may relate to kinematic variations. The purpose of this study was to determine if kinematic variations are likely to account for differences in leg muscle recruitment between novice and highly trained cyclists.

### METHODS

Participants were ten novice and ten highly trained cyclists. Four experimental conditions of cycling at 55-60, 75-80 and 90-95 rpm and preferred cadence were investigated in random order. Three dimensional kinematics of the pelvis and lower limbs and orientation of the bicycle crank arms were measured. Coordinates of 14 mm reflective markers were sampled at 250 HZ using a VICON 620 eight-camera motion analysis system (Oxford Metrics Ltd, Oxford, England). Marker trajectories were filtered using a GCVSPL algorithm to remove low frequency movement artifact and three dimensional kinematics were calculated using the Plug in Gait® model which has been described and validated previously (Version 1.8, Oxford Metrics Ltd: Oxford, England). Electromyographic (EMG) activity of leg muscles was also measured using methodology previously described [1] in three novice and two highly trained cyclists to confirm comparisons were of novice and highly trained cyclists in whom muscle activity varied as previously reported.

### RESULTS AND DISCUSSION

The comparison of EMG data was consistent with previous findings of varied muscle activity between novice and highly trained cyclists. Patterns of movement (i.e. time series kinematic data) did not vary between novice and highly trained cyclists, but the absolute range of sagittal plane motion of the ankle was significantly less in novice cyclists ( $13.2 \pm 7.7^\circ$ ) than in highly trained cyclists ( $21.5 \pm 9.0^\circ$ ). Absolute ranges of motion of the pelvis, hip and knee was not different between groups. Cadence did not influence kinematics of the pelvis, hip, knee or ankle in either group.

Sagittal plane motion of the hip and ankle (i.e. hip flexion-extension and ankle dorsiflexion-plantarflexion) and knee and

ankle (i.e. knee flexion-extension and ankle dorsiflexion-plantarflexion) were more coordinated in highly trained cyclists ( $r = 0.85 \pm 0.07$  and  $0.76 \pm 0.08$ ) than novice cyclists ( $r = 0.65 \pm 0.10$  and  $0.53 \pm 0.08$ ). Sagittal plane motion of the hip and ankle, and knee and ankle, were also more consistently coordinated (i.e. the degree of coordination between these movements varied less between pedal strokes) in highly trained cyclists ( $0.04 \pm 0.02$  and  $0.05 \pm 0.02$ ) than in novice cyclists ( $0.09 \pm 0.03$  and  $0.11 \pm 0.02$ ). Coordination and variability of coordination of sagittal plane hip and knee motion did not vary between groups.

Individual variance (i.e. variability of movement patterns between pedal strokes) did not vary between groups. Population variance (i.e. variability of movement patterns between cyclists) of flexion-extension of the hip was greater in novice cyclists ( $8.0 \pm 1.6^\circ$ ) than in highly trained cyclists ( $4.2 \pm 1.8^\circ$ ), but population variance of frontal motion of the knee was greater for highly trained cyclists ( $7.1 \pm 1.1^\circ$ ) than novice cyclists ( $4.4 \pm 1.2^\circ$ ). Population variance of other joint motions was not different between groups.

### CONCLUSIONS

This study suggests that kinematics of the pelvis, hip, and knee do not vary between novice and highly trained cyclists. Differences in leg muscle recruitment between novice and trained cyclists may be explained in part by kinematic variations at the ankle. However, kinematic variations between novice and highly trained cyclists revealed in this study are unlikely to explain all aspects of varied leg muscle activity (e.g. longer durations and less modulation of muscle activity in novice cyclists). Greater coordination of motion between the hip and ankle and knee and ankle joints may reflect more skilled control of movement in highly trained cyclists. Furthermore, differences in the response of leg muscle recruitment to altered cadence in novice cyclists and highly trained, in whom decreased modulation of muscle activity with increased cadence was seen, are not likely to be associated with kinematic variations as cadence did not influence kinematics.

### REFERENCES

1. Chapman A, Vicenzino B, Blanch P, Hodges P. Do muscle recruitment patterns differ between trained and novice cyclists? *Medicine and Science in Sports and Exercise* 2004;36:s169
2. McLean B. Neuromuscular and kinematic correlates of performance in cyclists. Masters Thesis. The University of Queensland, Brisbane, Australia: 1987