An Analysis of Lower Body Kinematics in Response to Changes in Speed in World-Class Walkers

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Introduction

Information on how race walkers modulate lower body kinematics with speed is of interest to coaches for developing informed training strategies for elite athletes. Therefore, the aim of this study was to evaluate lower body kinematics with changes in speeds that are adopted in race walking competition and training for Olympic athletes. Such information could be used to inform technical training drills.

Methods

Seven male Olympic race walkers (age: 26 yrs (± 4.2), stature: 1.80 m (± 0.04), mass: 63.6 kg (± 6.0)) volunteered to participate in the study. Participants race walked at three different speeds down a 40 m walkway. Speeds were relative to individual 10 km, 20 km and training paces and measured with dual-beam photocells (Witty, Microgate). Twelve optoelectronic cameras (Oqus 7, Qualisys) operating at 250 Hz collected kinematic data from 16 retroreflective markers. Kinematic data were processed (QTM 2.17, Qualisys) and exported (Visual 3D v5, C-motion) for analysis using a 4th order zero lag low pass filter with a 8 Hz cut-off frequency and time-normalised. Repeated measures ANOVA, post-hoc paired samples t-tests and effect sizes were calculated to compare discrete variables. Statistical parametric mapping (spm1d.org) was used to compare lower body kinematics in Matlab (R2016b, The Mathworks Inc.). An alpha level of 5% was set for all statistical tests.

Results

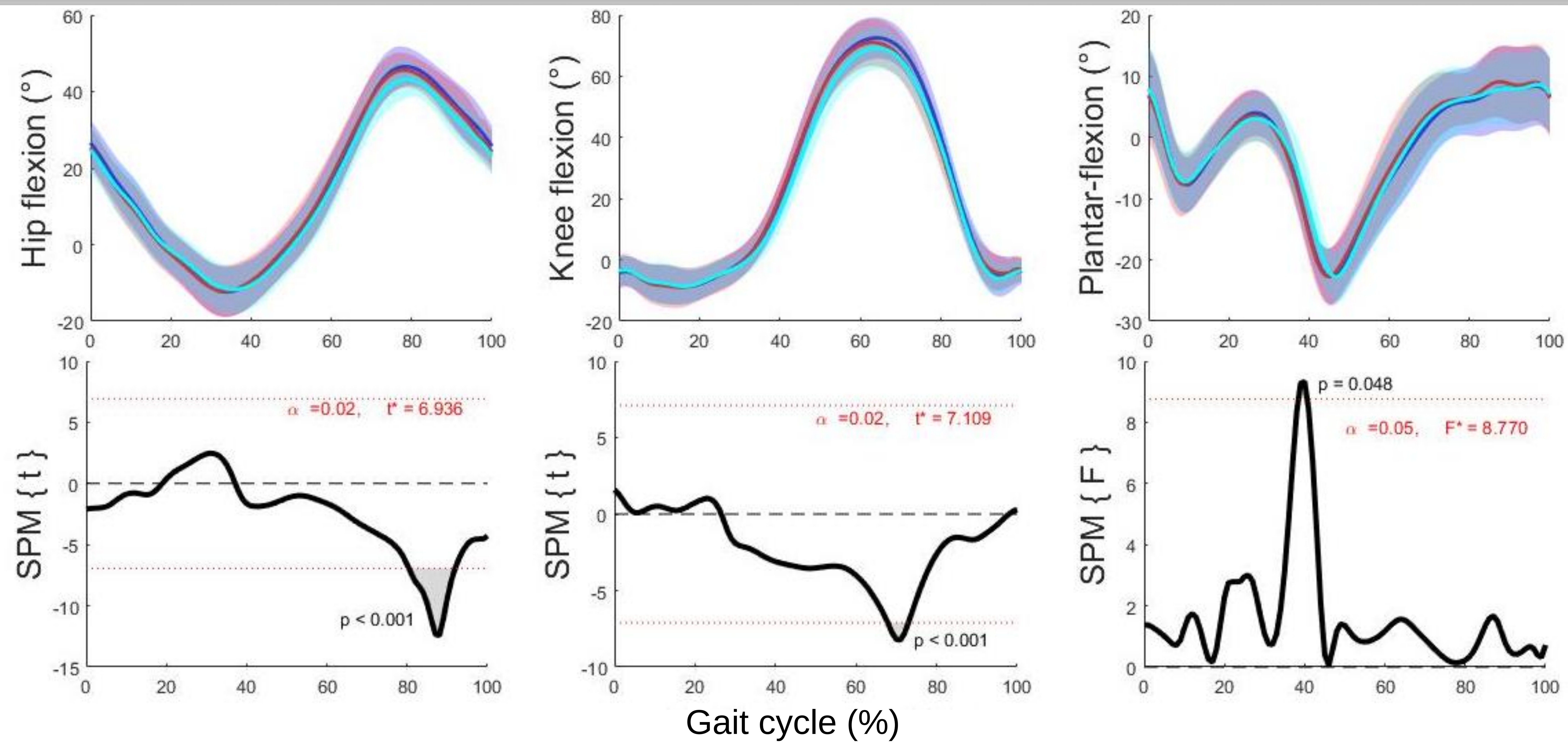

Figure 1. Mean sagittal plane kinematics with standard deviation (— 10 km, — 20 km and — Training) and corresponding statistical output.

Greater hip flexion (4°) was observed at 80-92% of the gait cycle in the 10 km trials than the training pace trials ($p < 0.001$, medium effect (0.65)). At the knee, greater flexion (3˚) occurred during the 10 km trials than the training pace trials at 68-73% ($p < 0.001$, medium effect (0.5)). No differences between conditions were found for the ankle. Hip angles in the transverse and frontal planes did not differ between race walking conditions at any point of the gait cycle. 10 km paces displayed greater step lengths than both 20 km (0.03 m, p = 0.002, medium effect (0.5)) and training paces (0.08 m, p = 0.023, large effect (1.33)).

Discussion

A more flexed hip during terminal swing in the 10 km trials might be indicative of the 0.08 m increase in step length that was present with increases in race walking speed. This hip flexion may have been the result of extra power generated by the hip to accelerate the swing leg forward during the fastest race walking speed measured. The knee showed greater flexion during swing in the 10 km compared to the training condition. Although the reduced moment of inertia might not be considered a critical factor to success in race walking (Smith & Hanley, 2013), it has been found here to differ with speed. Excessive knee flexion in race walking during swing should be avoided, as it has been previously been associated with greater, and potentially visible, flight times that are illegal within the sport (Smith & Hanley, 2013). This study suggests that elite race walkers modulate lower body kinematics by increasing range of motion of the hip and knee as speed increases. Coaches and athletes should consider an individualised approach to this kinematic strategy with respect to the rules of race walking.

References

Smith, L.C. and Hanley, B. (2013) Comparisons between swing phase characteristics of race walkers and distance runners. *International Journal of Exercise Science*, 6 (4), pp.269-277.

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