Whole body kinematic waveform comparisons between elite male and female race walkers

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Previous research that has identified sex-based differences in race walking gait has only considered joint positions at discrete time points such as initial contact and toe-off, potentially missing important data that occur between these gait cycle events. Therefore, the aim of this study was to compare full body kinematic waveforms of race walking gait between elite male and female race walkers. With institutional ethics approval, 15 male race walkers (mean age: 26 ± 5 years; stature: 1.78 ± 0.04 m; body mass: 64.7 ± 4.9 kg), and fifteen female race walkers (mean age: 28 ± 6 years; stature: 1.65 ± 0.08 m; body mass: 54.1 kg ± 8.4 kg) volunteered to participate in the study. Participants race walked down a 40 m walkway at speeds relative to their 10 km personal best. Twelve optoelectronic cameras (Oqus7, Qualisys) operating at 250 Hz recorded three-dimensional kinematic data from 64 retroreflective markers. Kinematic data were processed (QTM 2.17, Qualisys), time-normalised and filtered (Visual3D v5, C-motion). Statistical parametric mapping (spm1d.org) independent samples t-tests were computed for comparisons in Matlab (R2016b, The Mathworks Inc.) with an alpha level of 5%. Overall, there were very few kinematic differences between male and female race walkers. Women had more thorax rotation: just after (0-9%, $P = 0.015$) and before (92-100%, $P = 0.015$) initial contact they were more externally rotated than men. During late stance and early swing, women were more internally rotated (56-13%, $P < 0.001$). Women also had greater internal pelvic rotation after initial contact (~3-5%, $P = 0.033$), and hip internal rotation during stance (18-26%, $P < 0.001$). Women's knees extended more just before toe-off (46%, $P = 0.021$), and flexed less during swing (61-63%, $P = 0.033$). Finally, women also had greater ankle dorsiflexion immediately after (0-3%, $P = 0.020$) and immediately before (95-100%, $P = 0.010$) initial contact. The greater thorax rotation could be explained by women's smaller upper body segments, which require greater rotation to compensate for smaller moments of inertia. Greater dorsiflexion around initial contact is thought to enhance step length by increasing the effective leg length by projecting the heel forwards (Murray et al., 1983. *The American Journal of Sports Medicine*, 11, 68-74), and could be a compensatory mechanism for shorter leg lengths. Despite largely similar race walking gait patterns, coaches should be mindful of the subtle differences between elite male and female race walking kinematics.