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Continuous kinematic gait analysis during a marathon to objectify the influence of fatigue

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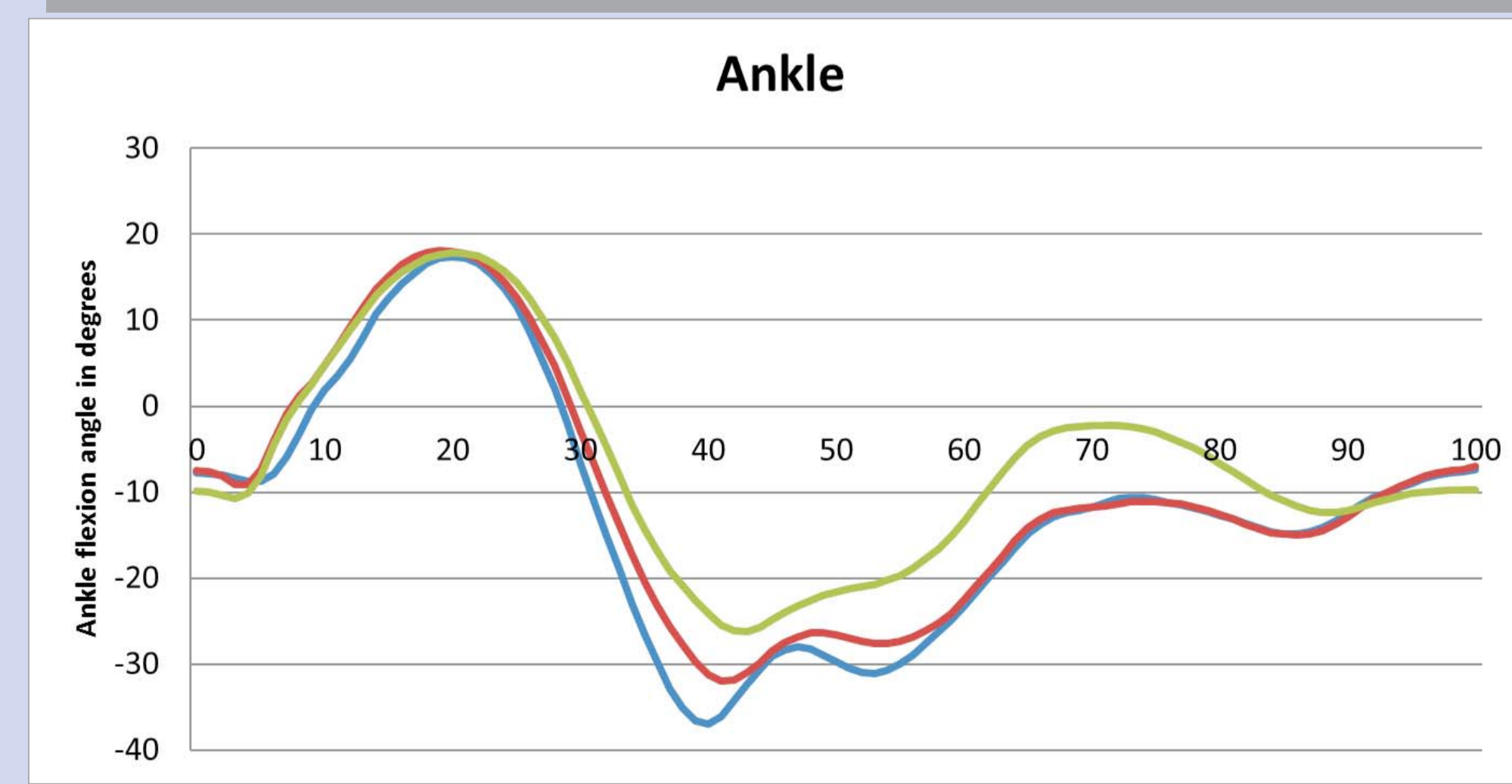
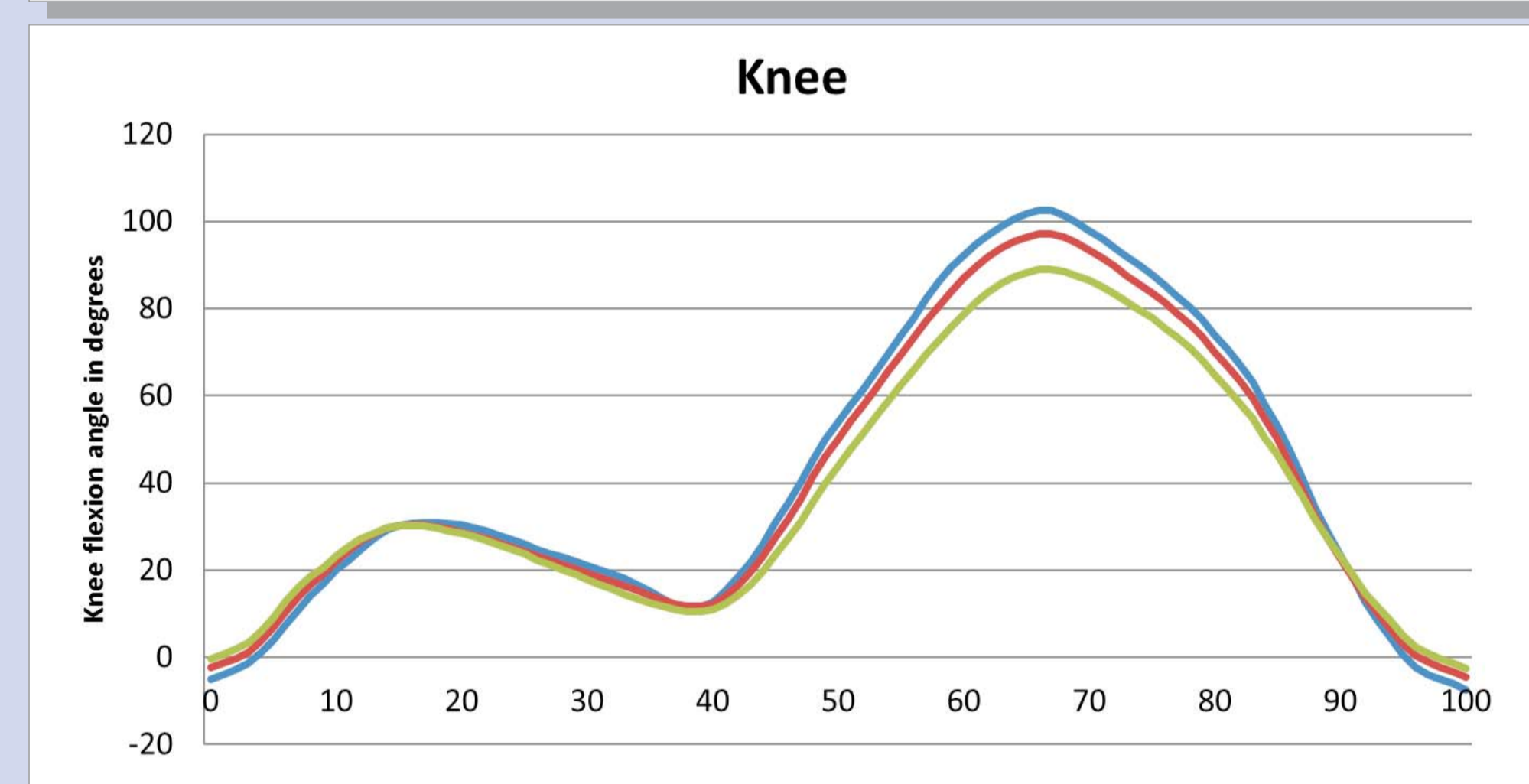
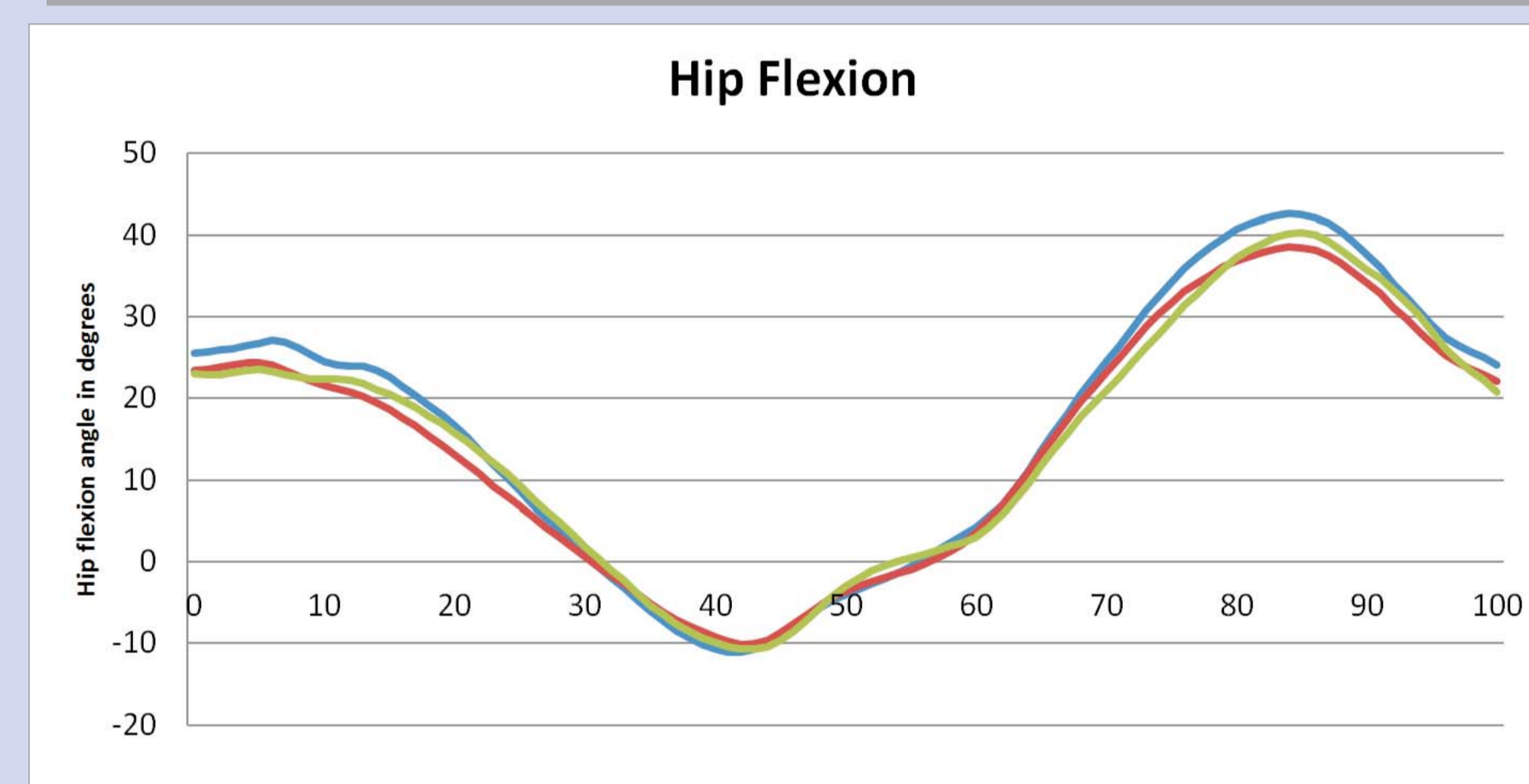
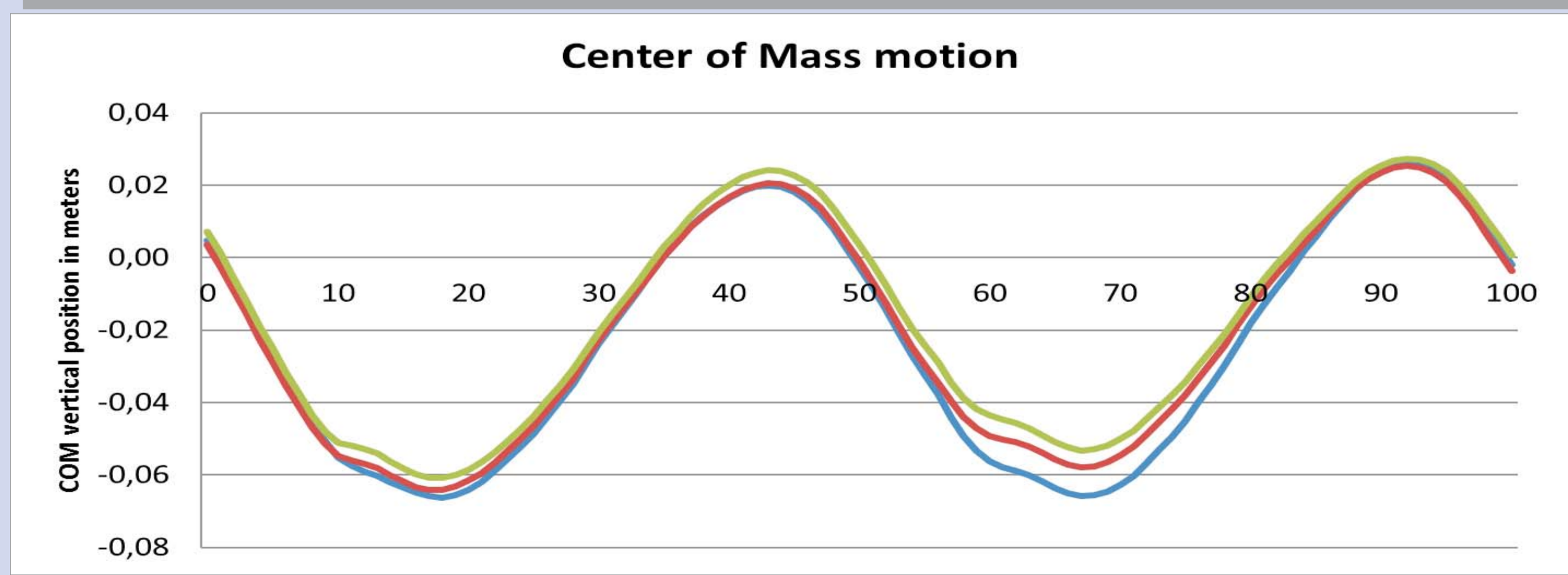
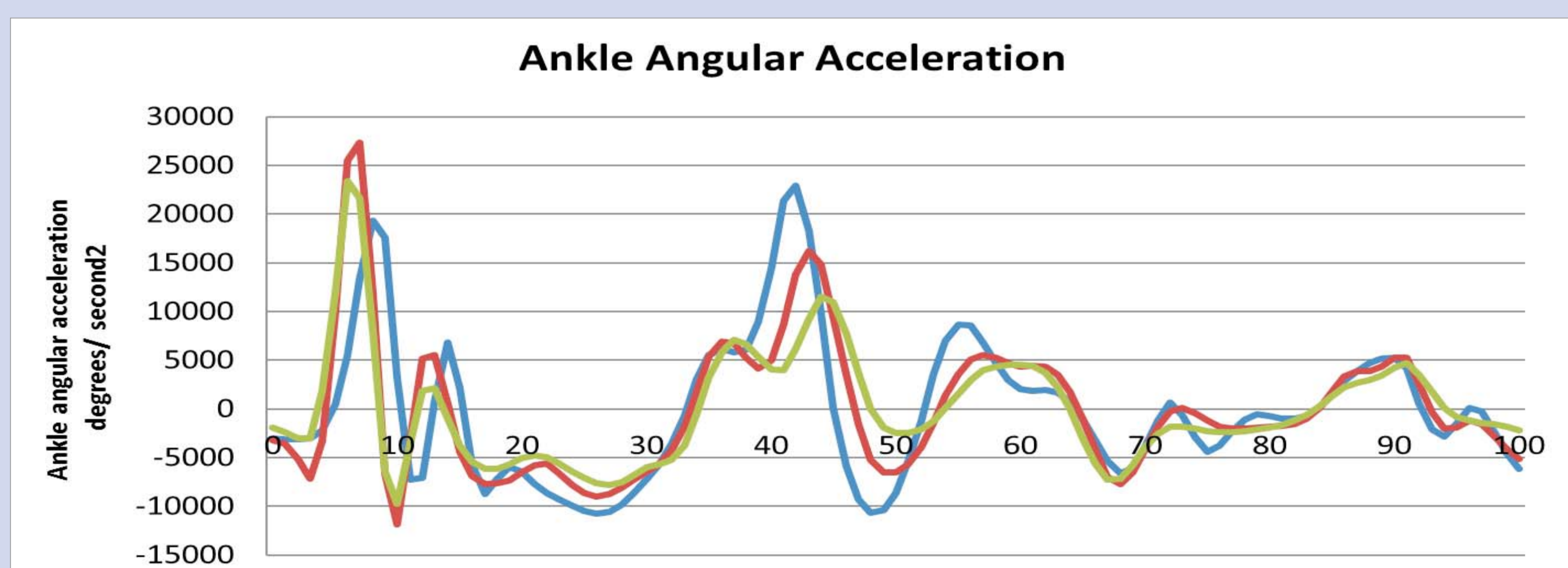


Introduction: Running is associated with a high incidence of injuries. Fatigue is known as an important factor in the development of injuries. This study aims at a continuous 3D kinematic analysis of running technique in the sport specific setting, and to objectify the influence of fatigue.

Methods: One trained male runner (31 yrs, 1.82m, 79 kg), equipped with 8 wireless inertial sensors on sternum, pelvis, upper- and lower legs and both feet, completed the 2013 Enschede Marathon. Fatigue was defined as the ratio of Heart Rate (HR) and Velocity. Three stages were analyzed at 13.5, 33.9 and 39.0 km. For each stage 200 cycles were identified, from which joint angles, ankle angular acceleration and vertical oscillation of the center of mass were normalized to gait cycle and averaged. Stride length and step frequency were calculated from combined GPS and inertial sensor data.

	Stage1	Stage2	Stage3
Distance	13,5	33,9	39,0
Distance covered for 200 strides (meters)	525,8	464,4	432,1
MeanVelocity (km/h)	13,5	12,0	11,2
Stride Duration_M (seconds)	0,69	0,69	0,69
Stride Length_M (meters)	2,61	2,31	2,15
Step Frequency (steps per minute)	173	174	173
Heart Rate (BPM)	148	158	155
Fatigue ratio	10.9	13.1	13.8

Results: The HR-Velocity ratio increased during the marathon. Stride length decreased from 2.59 to 2.15 meters. Averages of ankle plantar flexion and peak knee flexion decreased during (mid-) swing; peak ankle plantar flexion decreased at toe-off. Ankle angular acceleration decreased around toe-off. Center of Mass vertical oscillation decreased asymmetrically.



Conclusion: This study showed the possibility of performing a continuous 3D kinematic gait analysis during a marathon and of objectifying the influence of fatigue on the running technique.



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