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USE OF 2-DIMENSIONAL SAGITTAL KINEMATIC VARIABLES TO ESTIMATE GROUND REACTION FORCE DURING RUNNING

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ABSTRACT

Background: Variations in vertical loading rates have been associated with overuse injuries of the lower extremity; however, they are typically collected using 3-dimensional motion capture systems and in-ground force plates not available to most clinicians because of cost and space constraints.

Purpose: The purpose of this study was to determine if kinetic measures commonly used to describe lower extremity loading characteristics could be estimated from step rate and specific sagittal plane kinematic variables captured using 2-dimensional motion analysis during treadmill running.

Study Design: Observational Study

Methods: Ten high school cross-country runners (4 men and 6 women) voluntarily consented to participate in this study. Reflective markers were placed on each lower extremity over multiple anatomical landmarks. Participants were then asked to run on the instrumented treadmill at their preferred running speed. When the participants indicated they were in their typical running pattern, they continued to run at their preferred speed for a minimum of five minutes. After three minutes of running at their preferred running speed, the participant's step rate was counted and after running for four minutes, video and ground reaction force data were recorded for 60 sec. All running motion data were recorded using a single high-speed camera at 240 frames per second and ground reaction force data were sampled at 1000 Hz.

Results: Mean kinematic values between the left and right extremities for all 10 participants were not significantly different. Consequently, data for the left and right extremities were grouped for all further analyses. The stepwise forward regression to predict vertical ground reaction force resulted in a five-variable model (step rate and four kinematic variables) with $R^2 = 0.56$. The stepwise forward regression to predict average loading rate also resulted in a five kinematic variable model with $R^2 = 0.51$.

Conclusions: Step rate and sagittal plane kinematic variables measured using a simplified 2-dimensional motion analysis approach with a single high-speed camera can provide the clinician with a reasonable estimate of ground reaction force kinetics during treadmill running.

Level of Evidence: 4, Controlled laboratory study

Keywords: gait analysis, loading rate, running assessment

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