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Kinematics of pelvis during maximal sprint running: gender differences in its relation to running velocity

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INTRODUCTION:
Many studies have investigated the lower limb kinematics of maximal sprint running. However, few have focused on the pelvis; the root of the lower limb. As it plays a substantial role in lower limb movement, it is important to investigate the kinematics of pelvis during maximal sprint running and its influence on maximal running velocity. The aim of this study was to examine the relationship between pelvic kinematics and running velocity during maximal sprint running and its gender differences.
METHODS:
Japanese track and field athletes (52 males and 52 females, including sprinters, hurdlers, long jumpers, decathletes and heptathletes) participated in this study. Their maximal sprint running was captured using a 250-Hz optical motion capture system. Kinematic parameters of the pelvis during the stance phase, e.g., 3-dimensional angles at toe-on and toe-off, angular displacements, and peak angular velocities, were obtained from two consecutive left and right steps of each athlete. Multiple regression analyses were performed separately for males and females, with each kinematic parameter as a dependent variable and running velocity, leg length, and step frequency as explanatory variables. Leg length and step frequency were included to standardize the influence of body dimensions and spatiotemporal characteristics of running. The relationships were determined based on the statistical significance (α=0.05) of the standardized partial regression coefficients (β).
RESULTS:
All athletes showed a similar pattern of pelvic movement during maximal sprint running: the pelvis tilted anteriorly; tilted ipsilaterally to the stance side; and rotated slightly ipsilaterally, then counter-rotated contralaterally during the stance phase. In males, the kinematic parameters relevant to anterior tilt were only related to the running velocity (β = 0.373, 0.248, -0.295, -0.252, for the anterior tilt angle at toe-on, that at toe-off, anterior angular displacement, and peak anterior angular velocity, respectively). In females, however, the kinematic parameters relevant to late stance rotation were only related to the running velocity (β = 0.288, 0.255, 0.353, for the maximum ipsilateral rotation angle, contralateral counter-rotation angular displacement, and peak contralateral counter-rotation angular velocity, respectively).
CONCLUSION:
The current results suggest that pelvic kinematics have a substantial influence on maximal running velocity, and the underlying mechanisms may differ between males and females. A more anteriorly tilted and stabilized pelvic motion may contribute to running velocity in males, whereas a larger and faster rotational motion may contribute in females. Gender differences in shape of the pelvis, i.e., more vertical in males and wider in females, lead to a difference in its moment of inertia around each axis, which may result in the different pelvic movement requirements for higher maximal running velocity between males and females.

Topic: Biomechanics

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