CHANGING STEP WIDTH ALTERS LOWER EXTREMITY KINEMATICS DURING RUNNING

Clare E. Milner, Richard A. Brindle, Songning Zhang, Eugene C. Fitzhugh

University of Tennessee, Knoxville, TN, USA
Email: milner@utk.edu

INTRODUCTION

Frontal and transverse plane lower extremity kinematics are associated with overuse knee injuries in runners [1, 2]. Step width is a frontal plane variable which may influence lower extremity kinematics while running. Previous research has reported that rearfoot angle changes with step width alterations during running [3]. The effects of changes in step width during running on the knee and hip have not been reported. Furthermore, differences in hip and knee kinematics are also apparent between male and female runners [4]. The purpose of this study was to determine the effect of changing step width during running on lower extremity kinematics in healthy male and female runners. We hypothesized that peak hip, knee and rearfoot angles during running will differ among the step width conditions and between genders.

METHODS

Twenty six healthy runners participated in this study, half of them male. Participants were between the ages of 18 and 35 years old, and have been running at least 15 miles a week for at least a year (age: 24.7 ±3.9; height: 1.7 ±0.1; weight: 66.0 ±9.3; miles/week: 31.3 ±18.0). Each participant provided written informed consent and completed a Physical Activity Readiness Questionnaire before participating. Participants’ leg length was measured. A nine camera motion capture system collected marker position data at 120 Hz. Ground reaction force data were collected at 1200 Hz using a force plate synchronized with the motion capture system. Running velocity (3.5 m/s +/-5%) was monitored via two photocells and a timer. Participants ran with their preferred step width for the control condition. The order of the subsequent experimental conditions was randomized. During the wide condition, participants ran with a step width of 20% leg length. During the narrow condition, participants ran with a step width of 0% leg length. Target step width was indicated by tape placed along the runway. Participants took several practice trials for each condition. Five right side trials were collected per condition. Data were processed using joint coordinate systems and rigid body assumptions. The dependent variables were peak hip adduction angle, peak hip internal rotation angle, peak knee internal rotation angle, and peak rearfoot eversion angle. The dependent variables and step width were each analyzed statistically using a 2 x 3 (gender x step width) mixed model ANOVA. Least significant difference post hoc tests determined where any significant differences lay for step width or interaction effects. Differences were considered significant if p < 0.05.

RESULTS AND DISCUSSION

The step width during running was altered from preferred width in both narrow and wide conditions (p < 0.001), and was similar in men and women (p = 0.454) with no interaction effect (Table 1). In general, there was a continuous increase in peak values for
the dependent variables as step width changed from wide, to preferred, to narrow. Greater peak angles for the hip and knee dependent variables have been associated with overuse knee injuries in runners. There were no interactions between step width condition and gender for any dependent variable (p > 0.05), indicating that men and women responded similarly to changes in step width during running. However, several variables differed between men and women, with women tending to have larger peak angles. Specifically, peak hip adduction angle was larger with narrower steps (p = <0.001) and in women (p = 0.012). Peak hip internal rotation angle was similar across step widths (p = 0.071) and gender (p = 0.438). Peak knee internal rotation decreased slightly as step width decreased (p = 0.004), and was larger in women (p = 0.044). Peak rearfoot eversion angle increased as step width decreased (p = <0.001) and was similar in men and women (p = 0.100).

There was an inverse relationship between step width and peak hip adduction angle. Thus, running with narrow steps causes hip adduction more like that of runners with overuse knee injury [1, 2]. The opposite was also found: running with wider steps reduces peak hip adduction angle. This may be beneficial in runners with excessive hip adduction.

The inverse relationship between step width and peak rearfoot eversion angle has been reported previously [3]. Peak hip adduction angle and peak knee internal rotation angle during running were larger in women than men. Greater peak hip adduction angle in female compared to male runners has been reported previously [4].

**CONCLUSION**

Changing step width influences hip and rearfoot kinematics during running. Running with wider steps reduced peak hip adduction and rearfoot eversion angles in healthy runners.

**REFERENCES**


<p>| Table 1: Dependent variables among step width conditions, mean (standard deviations) |
|-----------------------------------------------|---------------|---------------|---------------|</p>
<table>
<thead>
<tr>
<th>Step Width (cm)*</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Hip Adduction Angle (°)*</td>
<td>12.9 (3.2)</td>
<td>17.1 (3.6)</td>
<td>12.4 (3.4)</td>
<td>15.0 (3.9)</td>
<td>8.0 (3.3)</td>
<td>12.0 (4.0)</td>
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<td></td>
</tr>
<tr>
<td>Peak Hip Internal Rotation Angle (°)</td>
<td>10.6 (5.1)</td>
<td>8.7 (4.8)</td>
<td>11.0 (5.4)</td>
<td>9.4 (4.5)</td>
<td>9.9 (5.5)</td>
<td>8.9 (4.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Knee Internal Rotation Angle (°)</td>
<td>1.5 (5.7)</td>
<td>5.7 (4.4)</td>
<td>2.2 (5.7)</td>
<td>6.3 (3.7)</td>
<td></td>
<td></td>
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<tr>
<td>Peak Rearfoot Eversion Angle (°)</td>
<td>6.0 (3.7)</td>
<td>8.7 (4.0)</td>
<td>5.2 (3.4)</td>
<td>7.4 (3.9)</td>
<td>3.6 (3.8)</td>
<td>6.3 (4.5)</td>
<td></td>
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</tr>
</tbody>
</table>

Post-hoc tests indicate significant differences among step width conditions: *all different; different to Nnarrow, Ppreferred, Wwide.