THE RELATIONSHIP BETWEEN HIP EXTENSOR STRENGTH, JUMP HEIGHT AND EXTERNAL HIP FLEXION MOMENTS DURING JUMPING

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INTRODUCTION

• Increasing maximal vertical jump height (MJH) may improve sport performance.
• Torque produced by the hip extensors during jumping is the single largest predictor of MJH during a countermovement jump (CMJ) (Ford, 2009); however, this relationship has not been examined during an asymmetrical jumping task, such as the one-step CMJ (Lawson, 2006).
• The relationship between hip extensor strength and the torque produced during a jumping activity or MJH has not been extensively studied, yet previous studies have reported no relationship between isometric hip strength and MJH (Chang, 2013).
• The relationship between concentric hip extensor strength and MJH or hip torque produced during jumping has not been studied.

PURPOSE

To determine the extent of the relationship between hip extensor strength, hip extensor torque produced during a jump and MJH during a one-step countermovement jump.

METHODS

Participants:
• Twenty-three Division-1 collegiate basketball players
  • 11 males- age: 20.4 ± 1.5 years, height: 1.89 ± 0.08 m, weight: 90.6 ± 10.8 kg.
  • 12 females- age: 20.0 ± 1.4 years, height: 1.73 ± 0.07 m, weight: 80.2 ± 13.6 kg.

Procedures:
• Participants were instrumented with 43 retroreflective markers for 3-D motional analysis with a 24-camera motion analysis system (Eagle cameras, Motion Analysis Corporation)

METHODS

One-Step CMJ:
• Participants started one leg length away from a target, stepped forward with one leg (LEAD), and immediately performed a maximal CMJ reaching up with both hands to a target suspended overhead (Figure 1).
• Three trials were performed while leading with the preferred and non-preferred (self-selected) jumping legs in randomized order.
• Vertical ground reaction forces (vGRF) were collected by in-ground, multi-axis force platforms (AMTI) sampled at 1200 Hz. Lower extremity joint moments were calculated in Visual3D (C-Motion).

Hip Extensor Strength Testing
• Participants were positioned prone on an isokinetic dynamometer (HUMAC NORM, CSMi Solutions,) while kneeling on their uninvolved limb (Figure 2) to measure isokinetic (60º/sec) concentric hip extensor strength between 90º - 30º.
• The peak force generated during the middle 3 of 5 trials were averaged and normalized to body mass for statistical analysis.

Statistical Analysis
• Pearson product-moment correlations were performed to examine the relationship between MJH, external hip flexion moments and hip extensor strength (p<0.05)

RESULTS

• There was a significant positive correlation between MJH and external hip flexion moment of both legs measured during the one-step CMJ when leading with the preferred (LEAD: r = 0.90, p < 0.001; TRAIL: r = 0.66, p = 0.001) and non-preferred (LEAD: r = 0.85, p < 0.001; TRAIL: r = 0.53, p = 0.01) jumping leg (Figure 4).
• Concentric hip extensor strength was not significantly correlated to either MJH or hip flexion moment (p>0.05) (Figure 5).
• Direct correlation was found between concentric hip extensor strength and a) MJH and b) hip flexion moment of the lead and trail leg.

SUMMARY AND CONCLUSIONS

• External hip flexion moments explain up to 81% of the variance of MJH values during a one-step CMJ
• Concentric hip extensor strength measured at 60º/sec was not related to MJH or hip flexion moments.
• Further examination of hip extensor function (e.g. activation, strength at higher speeds) may warrant future investigation.

REFERENCES


Table 1. Descriptive statistics of MJH, hip moment and hip strength.

<table>
<thead>
<tr>
<th>Jump Height (cm)</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
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<tbody>
<tr>
<td>Peak Hip Flexion Moment (Nm/kg)</td>
<td>LEAD</td>
<td>TRAIL</td>
<td>LEAD</td>
</tr>
<tr>
<td>Male</td>
<td>Female</td>
<td>Total</td>
<td>Male</td>
</tr>
<tr>
<td>2.44 ± 0.43</td>
<td>2.21 ± 0.38</td>
<td>2.36 ± 0.40</td>
<td>2.81 ± 0.48</td>
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Figure 1. Participant performing the one-step CMJ task.

Figure 2. Patient positioning during hip extensor strength testing.

Figure 3. Hip flexion moment ensemble curve during the one-step CMJ.

Figure 4. Scatter plots representing the relationship between jump height and hip flexion moments of the lead and trail leg.

Figure 5. Scatter plots representing the relationship between hip flexion moments and MJH.