A Gender Comparison of Lower Extremity Landing Biomechanics Utilizing Different Tasks: Implications in ACL Injury Research

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Anterior Cruciate Ligament

- One of 4 main ligaments in the knee
- Provides stability within the knee
- Injury of ACL can severely inhibit athletic performance
- Typically surgically repaired
- 6 month rehabilitation period
Problem

- Female athletes are 4 to 6 times more likely to sustain an ACL injury than their male counterparts.\(^4,5,6\)
Introduction

• Motion capture and electromyography (EMG) have been used to examine differences in males and females:
  – Studies found that women land with a straighter knee than men and are also quadriceps dominant.3,4, 9, 10

• Methods used in these Studies:
  – Drop landings from a height standard (i.e., 60 cm)1,7
  – Functional tasks (i.e., vertical jump).2,3,8, 9

• Standard heights may not be appropriate for all subjects and may elicit abnormal landing biomechanics in some subjects.2
Purpose of This Study

- Examine gender differences in leg biomechanics during different landing tasks, a drop landing and a functional vertical jump landing.

Female VS. Male
Subjects

- 17 subjects: 9 Female, 8 Male
- Recreationally active
- No history of significant knee injury
- Between 18 and 24 years old
- Recruited from UNH and community

<table>
<thead>
<tr>
<th>Subject Demographics (Average±SD)</th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>21.50</td>
<td>20.56</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>173.25</td>
<td>161.11</td>
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<tr>
<td>Weight (kg)</td>
<td>75.58</td>
<td>57.58</td>
</tr>
<tr>
<td>Max Vertical Jump (cm)</td>
<td>60.97</td>
<td>33.13</td>
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Instruments

• 6 camera, Hi-Res 3-D Kinematic Motion Capture System
  – EVaRT version 7
  – Motion Analysis Inc., Santa Rosa, CA
  – Sampling Rate 120 Hz

• EMG Data
  – EMG 100. BIOPAC System Inc., Santa Barbara, CA
  – Sampling Rate of 1080 MHz

• Force Platform
  – Model OR6-7-2000; Advanced Technologies Ins. Watertown, MA
  – Sampling rate 960 Hz
Methods and Procedure

• Consent
• Health history questionnaire
• Laboratory clothing and shoes
• 5-minute treadmill/stationary bike warm-up
• 12-retro-reflective markers placed on dominant leg
• 7 Electromyography (EMG) markers placed on quadriceps (quad) and hamstrings (ham) of dominant leg.
Procedure

• 2 landing tasks, random order
  – Self-initiated vertical jump (VJ)
  – Drop landing (DL)

• Subjects completed 6 successful trials in each condition

• Success:
  – Right foot on force plate
  – Balance
Procedure

QuickTime™ and a Microsoft Video 1 decompressor are needed to see this picture.
Procedure

QuickTime™ and a Microsoft Video 1 decompressor are needed to see this picture.
Data Analysis

• Dependent Variable:
  – Maximum knee flexion (MKF) angle during landing
  – Pre and post quadriceps and hamstring activation

• Individual trials exported (Excel)
  – Group means

• Import into SPSS software 13.0

• Two-way ANOVA (gender x task).
  – Alpha level = .05 or less
Kinematics Results

- **Vertical Jump** *(P = .001)*
  - Male = 83.38 ± 18.90
  - Female = 66.22 ± 15.01

- **Drop Landing**
  - Male = 75.55 ± 8.46
  - Female = 67.52 ± 6.31
EMG Results

- In both the VJ and DJ, no differences were found in EMG activation between males and females in the:
  - Quadriceps (quad)
  - Hamstrings (ham)
  - Quadriceps/ Hamstrings ratio (quad/ham)
Discussion of Results

- **No** gender difference in muscle activation of quad, ham, and quad/ham ratio before or after landing.
  - Chappell et al\textsuperscript{3,4} reported women were quad dominant

- MKF **similar** between gender in DL.
  - Huston\textsuperscript{8} and others reported females landed with less knee flexion from standard height drops (40, 60 cm).

- **Gender differences existed** during the VJ. Men had **greater** MKF than women.
  - Early study conducted by Swartz et al\textsuperscript{9} found no gender differences during vertical jump

- **Why the conflicting results?**
Conclusion

- On average men are capable of jumping at the same height of the drop jump height, while females can only jump half of the height.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean Max Vertical Jump (cm) ±SD</th>
</tr>
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<tbody>
<tr>
<td>Male</td>
<td>60.97 ±5.81</td>
</tr>
<tr>
<td>Female</td>
<td>33.13 ±9.76</td>
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</table>

- Researchers should continue to question the appropriateness of heights when creating research methodology.
Thank You

- Hamel Center for Undergraduate Research
- Dr. Erik Swartz, PhD
- Dr. Dain LaRoche, PhD
Questions?
References


