Finding the Best Injury Risk Assessment for the Lower Extremities

By Antonio Calderon

Dr. Raoul Reiser-Colorado State University
Dr. Emilie Gray-Colorado College
Sports Injuries: An Epidemic

- Huge cost and burden
- $1.8 billion/year in school-age children
- Single Big 10 Institution: 1317 injuries across 4 years
Limb Asymmetries

- Measurable difference in performance/function between L/R limbs
  - Hamstring strains
  - Lower back pain
  - ACL tears
Functional Movement Assessments

• Simple, repeatable movements that may reveal risky biomechanics
  • Kinetic Chain Theory, Force Platforms

3 categories of FMAs:

1. Drop Jump (DJ)
Drop Jump (DJ)
Functional Movement Assessments cont.

2. Countermovement Jump w/ Rebound (CMJR)
Countermovement Jump with Rebound Jump (CMJR)
3. Single-leg Countermovement Jump (SL CMJ)
Braking vs. Propulsive Movements

• **Braking**: muscle lengthening under load ("resisting")

• **Propulsive**: muscle shortening under load ("contracting")

• Measuring asymmetry in both phases of movements → more info about injury risk
Muscle Activation Patterns

- Past research in muscle activation/neurological control
- Each phase/movement type should be categorized!
  - Braking Phase vs. Propulsive Phase
  - Unilateral vs. Bilateral

Electrode placement during muscle activation analysis

(Sismek, 2017)
Research Questions

1. Are 4 functional movement assessments interchangeable? (DJ, CMJ (countermovement jump), RBJ (rebound jump), SL CMJ)

2. Do we get any additional information by dividing these movements into braking and propulsive phases?

DJ

---

CMJR (x2)

---

RBJ

---

SL CMJ

---

Etc.
Hypotheses

• 3 **Bilateral** Movements will correlate strongly

• **Unilateral** Movements (SL CMJ) will correlate weakly with **Bilateral** movements (DJ, CMJ, RBJ)

• **Braking** Force will correlate weakly with **Propulsive Force**
Methods

• N=104, 3 jump types (DJ, CMJR, SL CMJ), 3 trials each
• 4 movements analyzed: DJ, CMJ, RJ, SL CMJ
• Pearson’s Correlations
  • R>0.5 = Strong
  • 0.3<R<0.5 = Moderate
  • R<0.3 = Weak
Results: Bilateral vs. Bilateral Propulsive

\[ R = 0.679 \]

- \( R = 0.660 \) (CMJ – DJ)
- \( R = 0.708 \) (CMJ – RBJ)

ALL STRONG CORRELATIONS
Results: Bilateral vs. Bilateral Braking

**Drop Jump Braking**

**Rebound Jump Braking**

- **R = .573** *(RBJ – DJ)*

*only correlation we were able to make in this category*

**ALL STRONG CORRELATIONS**
Results: Unilateral (SL CMJ) vs bilateral propulsive

Drop Jump Propulsive

Single Leg Countermovement Jump Propulsive

R = .350 (SLCMJ – DJ)

.321 (SLCMJ - CMJ)

.278 (SLCMJ – RBJ)

ALL MODERATE/WEAK CORRELATIONS
Results: Propulsive vs. Braking

\[ R = 0.485^* \] (DJ)
\[ 0.440^* \] (RBJ)

*only were able to make two correlations in this category
## Conclusions

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Conclusion(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are any functional movement assessments interchangeable?</td>
<td>• - Bilateral movements correlate strongly $\rightarrow$ potentially interchangeable</td>
</tr>
<tr>
<td></td>
<td>• - Bilateral vs. Unilateral correlate weakly $\rightarrow$ not interchangeable</td>
</tr>
<tr>
<td>2. Any additional info from dividing into braking and propulsive?</td>
<td>• - Yes. Braking vs. Propulsive moderately correlated $\rightarrow$ not interchangeable</td>
</tr>
</tbody>
</table>

*All movements and phases provide unique information $\rightarrow$ should be used together*
Genetic Basis for Functional Asymmetry

- Early developmental signaling pathways $\rightarrow$ L/R body asymmetry $\rightarrow$ “handedness”
- Handedness could be associated with:
  - Asymmetry in muscular strength
  - Asymmetry in neuromuscular control
Other Important Factors to Consider

• Leg-Length Asymmetry
• Adaptive Asymmetries in certain sports
  • Baseball, Australian Football, Cricket Fast Bowlers
Future Directions

• Address limitations: control for prior activity, warmup type/duration, obtain medical records

• Larger sample size to perform inter-class correlations
  • Sex-Specific/Sport-Specific/Position-specific
  • Leg-length asymmetry classes
  • Measure limb strength and neurological control

• 3-D motion capture (Kinematic Variables)

(Cazzola, 2010)
Acknowledgements

• Dr. Raoul Reiser, Dept. of Health and Human Sciences, Colorado State University
• Dr. Emilie Gray, Dept. of Organismal Biology and Ecology, Colorado College
• Colorado State University Dept. of Athletics
• Colorado State University Dept. of Health and Human Science
• Gabrielle Hess, Caitlyn Helwig, Ross Lohrich
• Colorado College Dept. of Organismal Biology and Ecology
THANK YOU!

Any questions please let me know:

t_calderon@coloradoc College.edu
Supplemental Equations, etc.

• Asymmetry Equation: \[ \frac{((\text{Left limb force} - \text{Right Limb force})/((0.5)(\text{Right limb force} + \text{Left limb force}))\times100=\% \text{ asymmetry} \]