

MID-FLIGHT TRUNK MOTION INCREASED UNILATERAL LOADING DURING LANDING: A CENTER OF MASS ANALYSIS

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Literature Review

■ Background Information

– *ACL injury*

- Most common orthopedic repair

– (Ferrtti et al., 2010)

- ACL injury is the most frequent severe injury in many NCAA sports events, with an injury rate of 0.15 per 1000 athlete-exposures (Kay et al., 2017; Hootman, Dick, & Agel, 2007)
- Often at least 6 months before return to sport (Kvist, 2004)



Literature Review

■ Injury Conditions

- *Non- contact* (Tarmah, Rahnama, & Khayambashi, 2010)
- *Jump-landing and cutting* (Dai et al., 2015; Koga et al., 2010; Krosshaug et al., 2007)

■ Landing Biomechanics

- *Knee flexion angle*
 - Stiff landing technique (Devita & Skelly, 1992; Leppanen et al., 2016)
 - Associated with impact forces (Podraza & White, 2010)
 - Equal muscular strength between the quadriceps and hamstrings (Nagai et al, 2013).

Literature Review

■ Unilateral landings

- *Decreased maximum knee flexion angle* (Yeow, Lee, & Goh, 2010)
- *Greater ground reaction force* (Yeow, Lee, & Goh, 2010)

■ Trunk motion

- *ACL injuries often occurred when trunk motion was present* (Stuiecken et al., 2015; Walden et al., 2015; Hewett, Torg, & Boden, 2009)



Purpose

- The purpose of the current study was to quantify the effect of mid-flight medial-lateral trunk motion on center of mass (COM) distribution and subsequent landing biomechanics.

Hypothesis

- It was hypothesized that medial-lateral trunk motion would cause medial-lateral leg movements in the opposite direction, resulting in asymmetric landing and increased vertical ground reaction force (VGRF) to the leg closer to the total body COM.

Methodology

- 41 (18 male, 23 female) recreationally active participants
 - *Age: 22.0 ± 3.0 years*
 - *Height: 1.74 ± 0.10 meters*
 - *Mass: 71.0 ± 13.9 kilograms*
- 44 retro-reflective markers used for COM analysis
- 8 3D Cameras
- Vicon Nexus
- 2 Bertec Force Plates



Methodology

- Protocol

- *3 trials were completed in each of the 3 jump-landing conditions (Up, Right-reaching, and Left-reaching)*
- *Order was randomized*

Methodology

- "Up" Condition



Methodology

- “Right-reaching” Condition

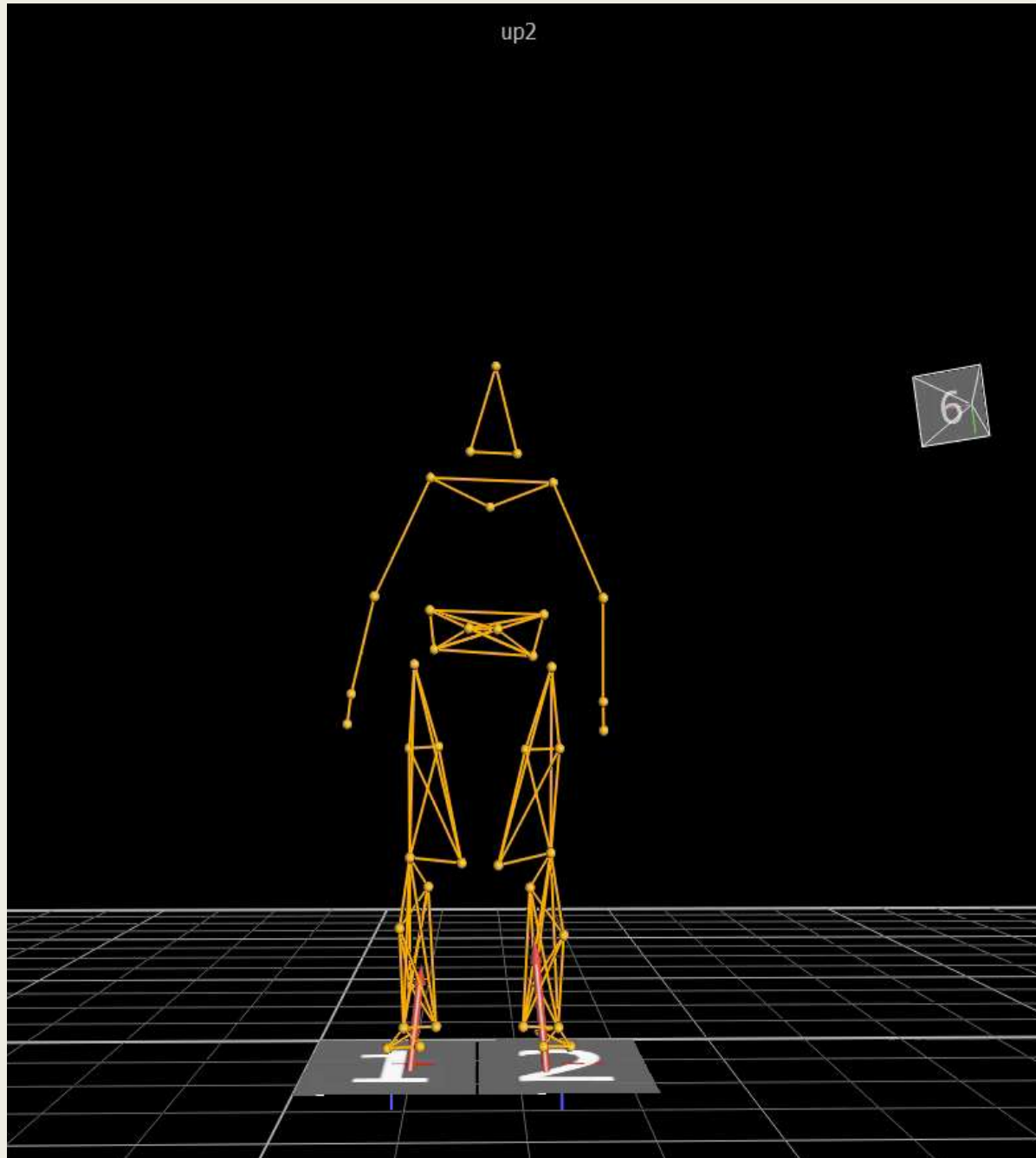


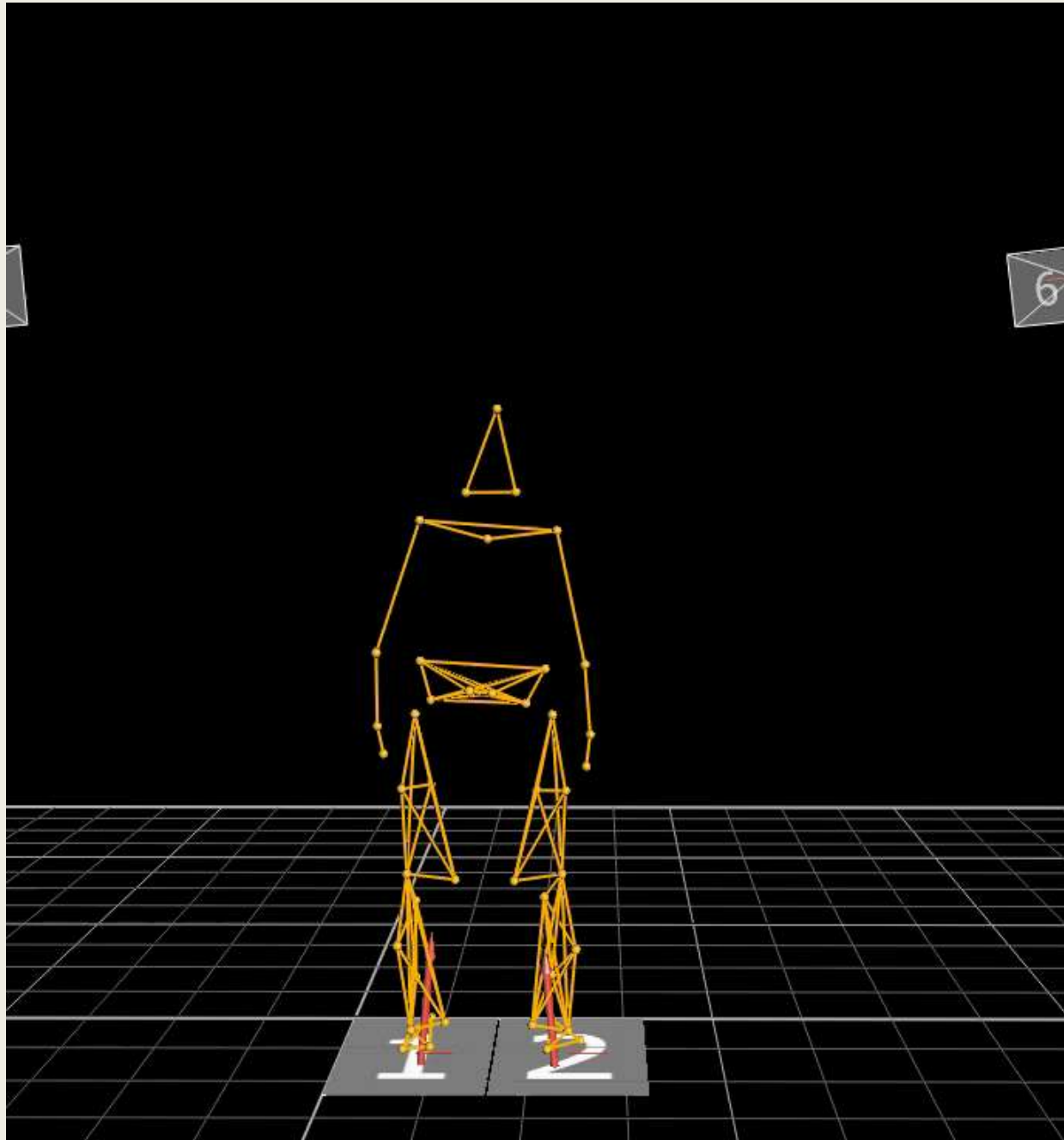
Methodology

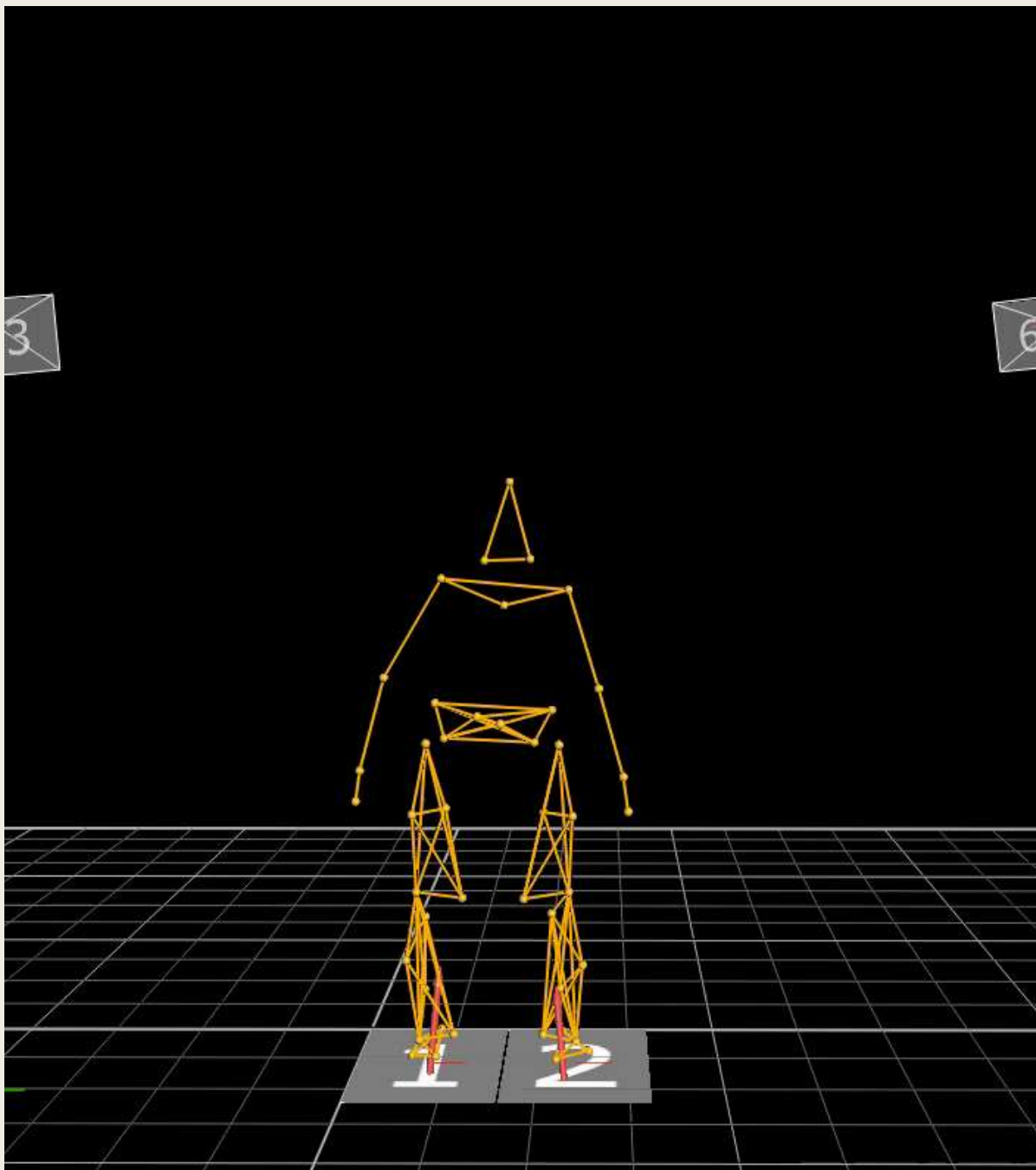
- “Left-reaching” Condition



up2



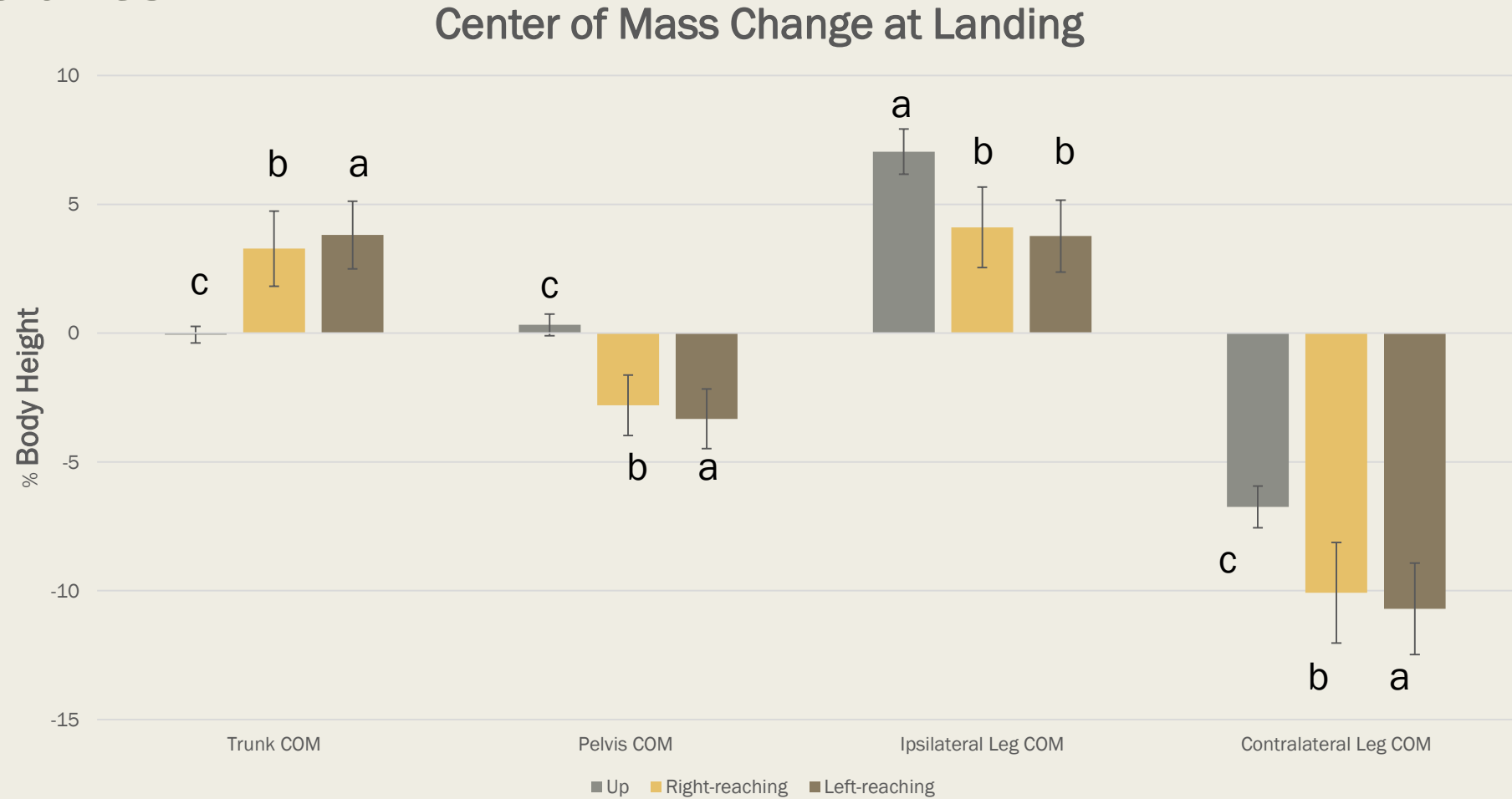




Results

- COM Analysis (% Body Height difference from Total Body COM)
 - *Upper Body COM*
 - *Pelvis COM*
 - *Ipsilateral Leg COM*
 - *Contralateral Leg COM*
- Landing Times (frames)
 - *Ipsilateral Leg*
 - *Contralateral Leg*
- Peak Vertical Ground Reaction Force (VGRF) (Force as proportion of Body Weight)
 - *Ipsilateral Leg*
 - *Contralateral Leg*

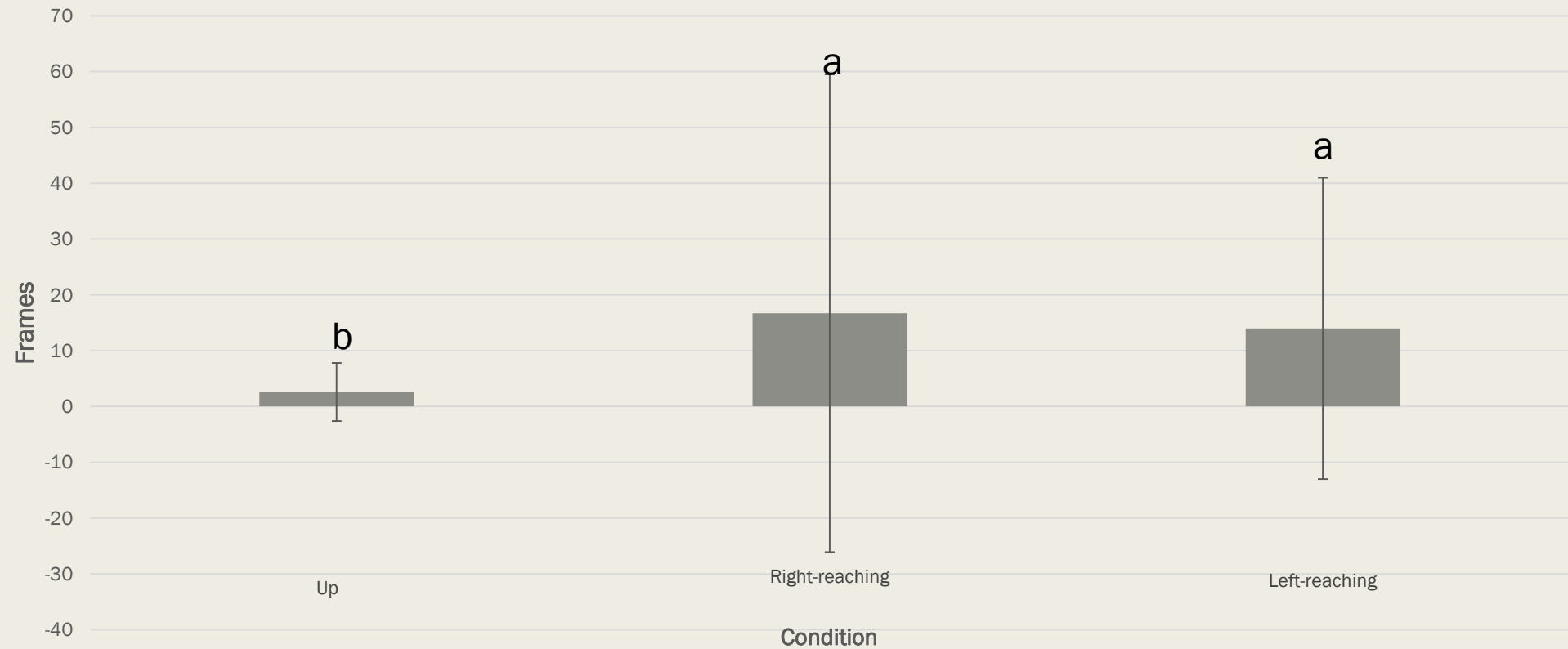
Results



Note: a>b>c at a significance level of 0.05

Results

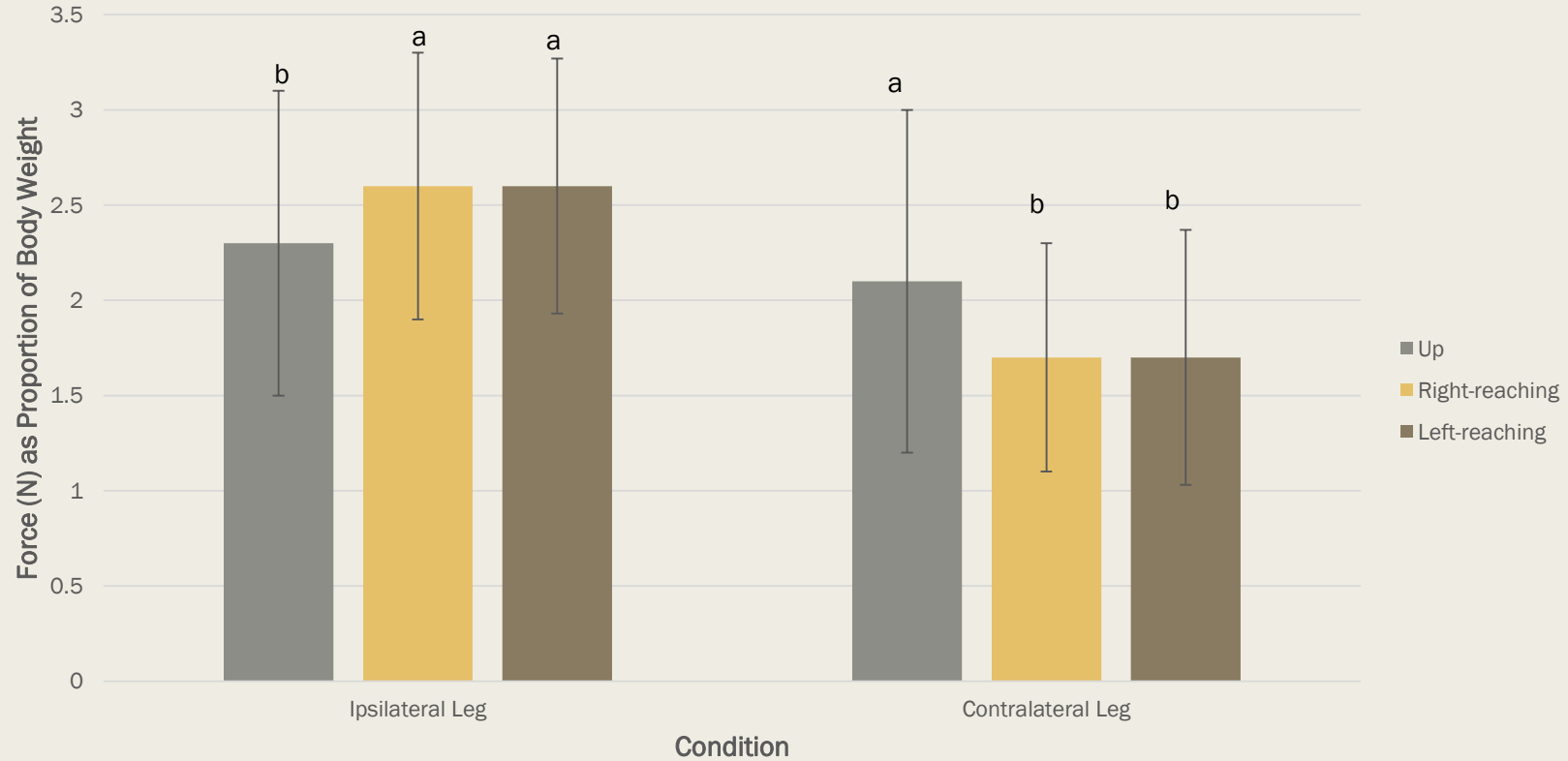
Time Difference at Initial Contact



Note: a>b>c at a significance level of 0.05

Results

Ipsilateral and Contralateral Leg Peak VGRF



Note: a>b>c at a significance level of 0.05

Discussion

■ Implications

- *Racket and jumping sports*

- In volleyball and badminton, most ACL injury cases involving a jump-landing, occurred in the knee opposite the spiking or racket arm (dominant arm; Devetag et al., 2016; Kimura et al., 2014).

■ Recommendations

- *Returning to natural, vertical position*
- *Increase knee and hip flexion for a softer landing*
- *Decrease muscular asymmetries*
- *Adapt effective falling strategies*

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■ Thank you!

■ Questions?