AN EXPLORATORY ANALYSIS OF VERTICAL GROUND REACTION FORCES DURING JUMP LANDING IN PEDIATRIC PATIENTS FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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BACKGROUND

- In the last decade, the rate of pediatric ACL reconstruction (ACLR) increased from 49.3 per 100,000 to 51.8 per 100,000.[1]
- Approximately 92% of youth athletes return to sport after an ACLR. [2]
- Jump performance tests are often implemented to test readiness for return-to-sport following ACLR.
- Performance tests, like a drop vertical jump (DVJ), allow for the athlete's performance to be analyzed under conditions individuals would experience during sport.[3]
- Adults demonstrate greater peak vertical ground reaction forces (vGRF) during jump-landing in comparison to healthy controls, which is linked to greater risk of reinjury and knee dysfunction. [4,5]
- However, it is unclear if pediatric ACLR patients demonstrate different peak vGRF during jump landing in comparison to uninjured pediatric controls.

PURPOSE

Primary Purpose: To determine the between-limbs effect sizes for pediatric patients (defined as Tanner Stage I-IV) and pediatric uninjured controls.
Secondary Purpose: To determine the between-group effect sizes for the ACLR limb of pediatric patients and the dominant limb of pediatric controls, and separately, for the ACLR limbs of pediatric and adult ACLR patients.
Hypotheses: Between-limb vGRF for pediatric patients will be similar. Additionally, that pediatric patients will have a similar vGRF to adult patients but not pediatric controls.

RESULTS

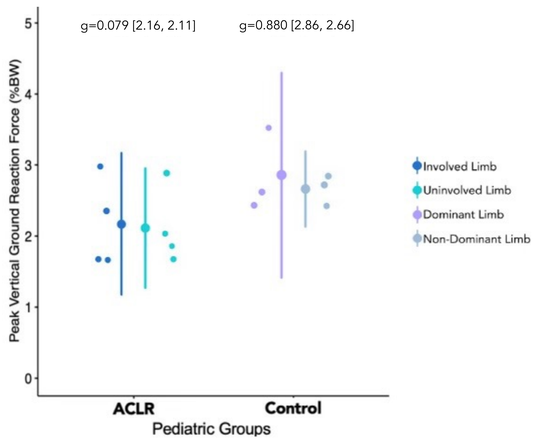

Figure 4. Group means and associated 95% confidence intervals for peak, jump-landing vertical ground reaction forces in the ACLR limb, contralateral limb, dominant limb, and non-dominant limb. Hedge's g effect sizes and means are shown above each group.

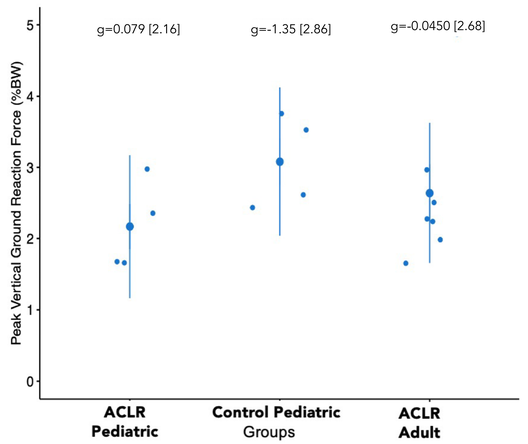

Figure 5. Group means and associated 95% confidence intervals for peak, jump-landing vertical ground reaction forces in the ACLR limb (Pediatric and Adult ACLR) and dominant limb for control pediatric participants. Hedge's g effect sizes and means are shown above each group.

Table 1. Demographic Information by Group

	Pediatric ACLR (n=4)	Pediatric Control (n=4)	Adult ACLR (n=7)
Age	**16.25± 2.5**	**14.5 ± 2.89**	**18 ± 3.27**
BMI (kg/m²)	**21.56 ± 1.87**	**19.24 ± 0.81**	**25.25 ± 2.65**
Sex (%Female)	**75%**	**50%**	**42.86%**

- Pediatric ACLR patients demonstrated a small between-limb effect size (Injured=2.16±0.63 vs. Uninjured= 2.11±0.53; g=0.079; 95% CI = -1.43, 1.58).
- A large effect size was observed between-limbs in pediatric controls (Dominant= 2.85±0.58 vs. Nondominant= 2.65±0.21, g= 0.88; 95% CI=-1.02, 2.78).
- Pediatric ACLR patients (2.16±0.63) exhibited a large effect size compared to pediatric controls (2.856±0.584; g=-1.35; 95% CI= -3.18, 0.472).
- Pediatric ACLR patients (2.16±0.63) exhibited a small effect size in comparison to adult ACLR patients (2.64±1.06; g=-0.45; 95% CI= -1.77, 0.853).

METHODS

Participants
- Participants were between 7 and 21 years of age and were within 6 months-2 years post-ACLR.
- Pediatric participants were sexually immature, based on a self-classification of a Tanner Stage I-IV. Adult participants were classified as a Tanner Stage V.

Drop Vertical Jump Analysis
- Kinematic data was collected at 1050 Hz and low-pass filtered at 10 Hz. (4th order recursive Butterworth)
- A drop-vertical jump task was performed from a 30-cm box (illustrated in Figures 1-3).
- Initial peak vGRF was extracted from the maximum vGRF value occurring upon initial landing (Figure 2).
- A minimum of 4 successful trials were collected for each participant.
- vGRF was averaged from the 4 jumping trials and normalized to the participant's body weight.

Statistical Analysis
- Hedge's g effect sizes were calculated between-limbs for pediatric ACLR patients and pediatric control in the primary analysis.
- Secondly, Hedge's g effect sizes were also calculated to compare the involved limb of pediatric and adult ACLR patients with the dominant limb of pediatric controls.
- 95% confidence intervals (CI) were constructed around the group means.

Figure 1. Participants stood on a 30cm tall box that was placed ½ their height away from the force plates.

Figure 2. Participants landed on 2 force plates embedded into the ground with 1 foot landing on each plate.

Figure 3. After landing, participants immediately jumped as high as possible.

DISCUSSION

Overall Findings
- The pediatric ACLR group demonstrated fairly symmetrical vGRF jump landing magnitudes between limbs.
- Peak jump landing vGRF magnitudes may vary by sexual maturation.

Limitations:
- We performed an exploratory analysis on a small sample size.
- Pediatric controls and ACLR adults were not directly matched to pediatric ACLR patients.

Future Directions:
- Future studies should determine if jump landing magnitudes differ by developmental stage and consider the impact of jump landing performance on long-term outcomes in pediatric ACLR patients.

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