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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, 2015)
- 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) followed by other (TRAIL), 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).

Figure 1. Participant performing the one-step CMJ task.

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 (60°/sec) concentric hip extensor strength between 90° - 30°.
- The peak force generated during the middle 3 of 5 trials were averaged and normalized to body mass for statistical analysis.

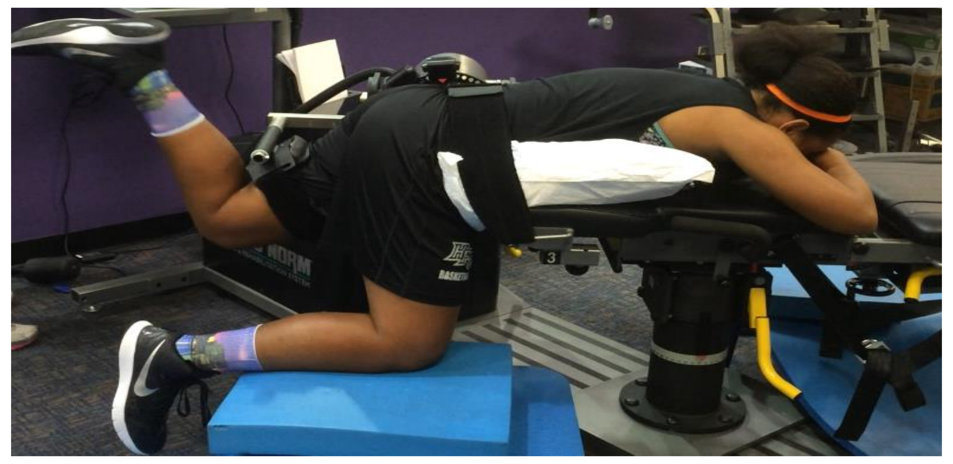

Figure 2. Patient positioning during hip extensor strength testing.

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

		PREFERRED		NON-PREFERRED	
		Lead	Trail	Lead	Trail
Jump Height (cm)	Male	68.4 ± 7.0		68.3 ± 6.7	
	Female	49.1 ± 4.1		49.3 ± 3.6	
	Total	58.3 ± 11.3		58.4 ± 11.0	
Peak Hip Flexion Moment (Nm/kg)	Male	2.87 ± 0.61	2.92 ± 0.61	2.61 ± 0.48	3.01 ± 0.70
	Female	1.46 ± 0.29	2.21 ± 0.58	1.58 ± 0.36	2.09 ± 0.49
	Total	2.14 ± 0.85	2.56 ± 0.69	2.08 ± 0.67	2.54 ± 0.76
Concentric Hip Extensor Strength (Nm/kg)	Male	2.37 ± 0.50		2.26 ± 0.41	
	Female	2.25 ± 0.47		2.36 ± 0.40	
	Total	2.31 ± 0.48		2.31 ± 0.40	

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

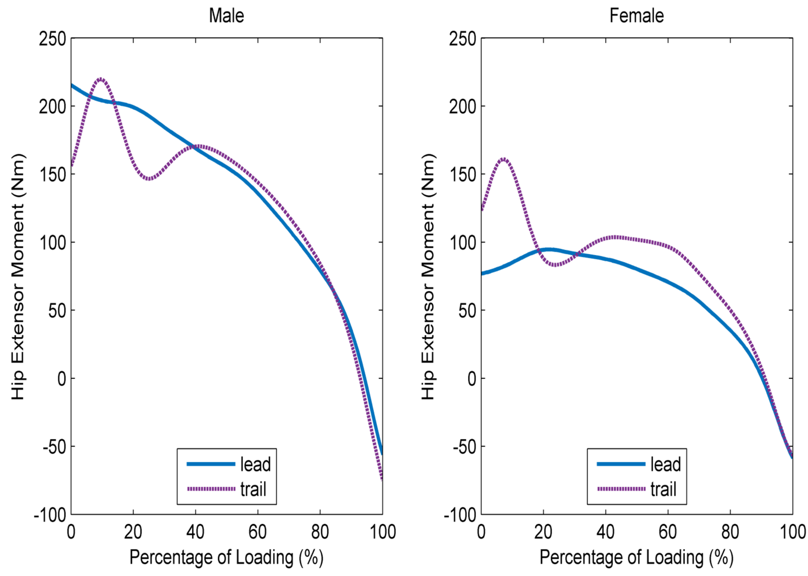

Figure 3. Hip flexion moment ensemble curve during the one-step CMJ.

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).

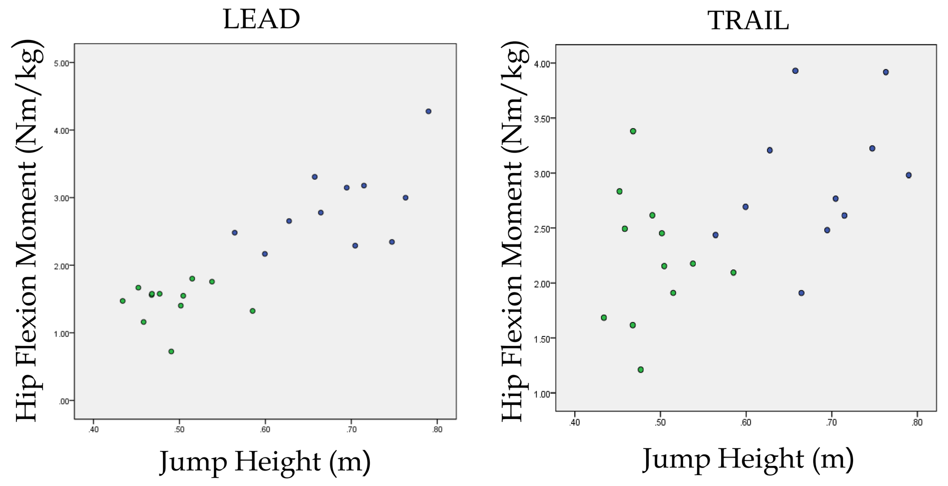

Figure 4. Scatter plots representing the relationship between jump height and hip flexion moments of the lead and trail leg.

- Concentric hip extensor strength was not significantly correlated to either MJH or hip flexion moments (*p*>0.05) (Figure 5).

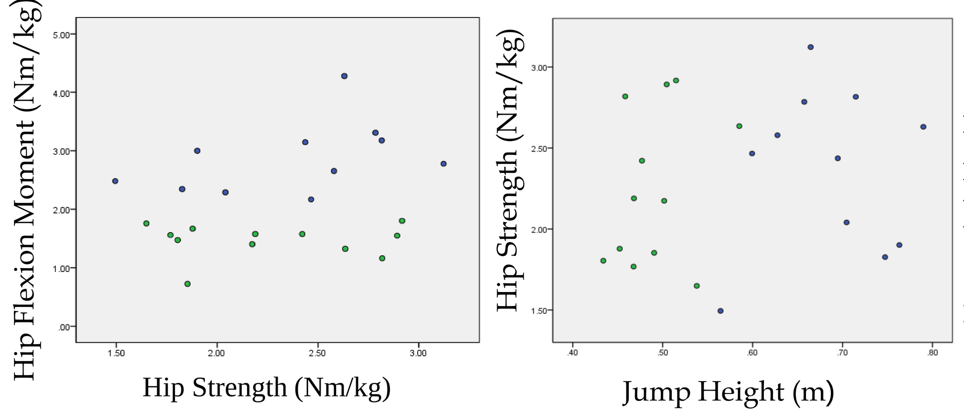

Figure 5. Scatter plots representing the relationship between hip strength and a) MJH and b) hip flexion moments in the lead leg.

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 60°/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

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