

EFFECTS OF GENDER ON LOWER EXTREMITY MUSCLE ACTIVATION IN CHILDREN PERFORMING A SINGLE-LEG UNANTICIPATED LANDING TASK

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INTRODUCTION

Although many studies have attempted to identify why anterior cruciate ligament (ACL) injury incidence is higher in female athletes than in males, few studies have investigated differences in muscle activation strategies in very young athletes. The purpose of this study was to compare lower-extremity muscle activation differences between preadolescent boys and girls when performing an unanticipated drop-landing task. The landing task incorporated a visual cue just prior to ground contact that guided the subject to run in one of three possible directions upon landing. The rationale of the unanticipated task was to simulate an actual game situation where an athlete must react to game circumstances while in free-fall.

METHODS

Thirty-eight subjects (17 males, 21 females) were recruited from a local youth soccer league. Anthropometric data are shown below.

Subjects were suspended from a horizontal bar 30.5 cm above the ground (Figure 1). Targets were placed directly in front of the

landing area, 30° to the left, and 30° to the right, all at a distance of 3.66m. Landing leg was determined before each trial. Subjects were instructed to, upon landing, run as fast as possible toward the illuminated target. Upon verbal command, subjects dropped onto one of two floor mounted force plates, landing on the pre-determined leg. One of the targets was randomly illuminated during free-fall.

Three trials were collected for each running direction and for each landing leg, totaling 18 trials per subject. The resulting three conditions were designated center (C), sidestepping 30° (SS), and crossover 30° (XO). The order in which the 9 trials were performed was randomized for each leg.

Muscle activation in the landing leg was monitored using surface electromyography (sEMG). The muscles of interest were the vastus lateralis (VL), vastus medialis (VM),



Figure 1: Female subject just prior to bar release.

Table 1: Anthropometric data (mean±SD)

	Age	Height (m)	Weight (N)
Males	10.44±0.63	1.44±0.08	354.53±53.73
Females	10.05±0.69	1.45±0.08	363.93±79.04

medial hamstring (MH), lateral hamstring (LH), and the medial head of the gastrocnemius (G). Signals were sampled at 1250 Hz and bandpass filtered from 20 to 500 Hz to remove motion artifacts.

Three phases of the landing were analyzed, pre-contact (PC), weight acceptance (WA), and peak push-off (PPO)(Besier et al. 2003). For each landing phase in each trial, maximum sEMG amplitude was determined for each muscle. Those values were then normalized to maximum voluntary isometric contraction (MVIC) data that were collected for the quadriceps and hamstrings groups prior to testing. In addition, all SS and XO trials were normalized to the average maximum sEMG amplitude during the C trials. For each subject, an average normalized sEMG value was calculated from the three trials of each condition during each of the three landing phases. The averaged normalized sEMG values were then compared in the statistical analysis. Differences between males and females were assessed for each variable using independent samples *t*-tests. Alpha level was set at $p < 0.05$.

RESULTS AND DISCUSSION

There were no significant differences between genders across all landing phases (PC, WA, PPO) and landing tasks (C, SS, XO) for the VL, MH, LH, and G muscles. However, significant differences between genders were noted at both PC and WA for the VM on all landing tasks (Table 2).

The boys in this study employed a landing strategy that included much higher VM amplitudes than did the girls, during both the PC and WA phases. That outcome may suggest that the males in this study were demonstrating a tendency towards “quadriceps dominance” in their landings as compared to the females, who, based on

previous research on older subjects, tend to demonstrate a more “ligament dominant” strategy when landing (Hewett et al, 2002; Ford et al, 2005). Ligament dominant strategies have been identified as potential etiological factors in non-contact ACL injuries (Hewett et al, 2002).

Table 2: Gender comparisons of the sEMG values (% MVIC) for the vastus medialis

Variable	Gender	Mean+SD	<i>t</i> -score	Sig.
PC-C	Male	1.99±1.28	2.501	0.015
	Female	1.36±0.83		
WA-C	Male	2.27±1.77	3.165	0.002
	Female	0.92±0.92		
PC-SS	Male	1.92±1.26	2.374	0.020
	Female	1.33±0.83		
WA-SS	Male	2.06±1.05	2.962	0.004
	Female	1.34±0.99		
PC-XO	Male	2.02±1.19	3.088	0.003
	Female	1.30±0.78		
WA-XO	Male	2.33±1.50	3.835	0.000
	Female	1.26±0.80		

PC=Pre-contact; WA=Weight acceptance; C=center run; SS=Side-step; XO=Crossover step

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