What Does the Single Leg Step Down Test Measure? Contributions of Core and Hip Strength

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INTRODUCTION

Lower extremity injuries are an increasingly common, and potentially devastating, occurrence among athletes of all ages. These sports-related injuries have significant personal, societal, and economic impacts.[1] The implications are even more sobering when focusing on specific injuries, such as anterior cruciate ligament (ACL) tears. There are over 200,000 ACL injuries in the US each year,[6] and some estimate that over 175,000 ACL reconstructions (ACL-R) are performed annually at a total cost of over $2 billion.[7] This has led to an increased focus on injury prevention mechanisms and a call for more objective and cost-effective[9] measures of readiness for return-to-play (RTP).[11]

Research has shown a connection between lower extremity injury and weak hip strength,[4] as well as decreased trunk control.[5] Although several studies have examined the connection between hip strength and performance on single leg squats or step-downs,[8] few studies have examined the relationship between trunk strength and these single leg activities. The goal of this study was to evaluate the relationship of hip and trunk strength with performance on the timed Single Leg Step-Down test (SLSD).

METHODS

71 participants, aged 19 to 45 years of age (mean 25.49 ± 1.24, 33 females, 38 males) completed this study. Isometric testing of hip abduction strength, hip external rotation strength, and hip extension strength was performed with a handheld dynamometer. Trunk strength was measured using timed plank and side plank bridging tests. The participant was required to hold the described plank positions for as long as possible.

The Single Leg Step-Down test (SLSD) was performed by having the participant stand on a 20 cm riser with a five cm tall scale placed directly in front of the riser. A single step-down repetition consisted of the participant flexing the stance (right) knee, touching the scale with the left heel with no more than 10% of body weight, and then returning to the start position. Performance on the test was recorded as the number of successful repetitions completed in a 60 second period.

Wizard for Mac (version 1.4.1) was used for statistical analysis. For hip strength tests, the average of all three measurements was converted to torque products and then normalized according to the mass. The independent correlation between each strength test and performance on the SLSD test was examined using the Pearson product-moment correlation coefficient and the Fisher exact test to determine significance. Multivariate regression models, using variables having a P value of ≤ 0.05 in univariate analysis, were used to identify independent predictors of SLSD performance. The level of significance for all analyses was set at p ≤ 0.05.

METHODS

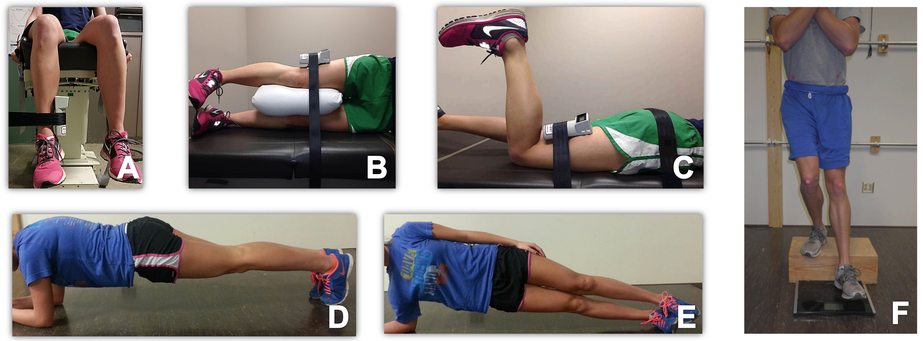

Figure 1: Demonstration of (A) hip external rotation (B) hip abduction, (C) hip extension, (D) plank, (E) side plank, and (F) step-down tests

RESULTS

KEY POINTS

- Plank time was a significant predictor of SLSD performance
  - This effect was strongest in females
- Plank and side plank times, hip abduction, hip external rotation, and hip extension strength were all significantly correlated with SLSD performance in univariate analysis
- The SLSD test can be used as a screening tool to identify individuals with weak trunk and hip strength, and may be useful in injury prevention and return-to-play screening in the setting of ACL injury

Table 1: Multivariate Regression Analysis of Factors Influencing Single Leg Step-Down Performance

	Coefficient	SE	P-value
Plank*	0.077	0.023	0.001
Females*	0.063	0.021	0.005
Side Plank	0.041	0.053	0.440
Females	0.029	0.05	0.572
Hip Abduction†	0.700	0.359	0.055
Females	0.403	0.306	0.197
Hip External Rotation	0.791	0.709	0.268
Females	-0.036	0.823	0.966
Hip Extension	-0.051	0.317	0.873
Females	--	--	--
Tegner Activity Scale	-7.01	1.394	0.617
Females†	2.537	1.411	0.081

* Statistically significant correlations. † Trend toward significance.

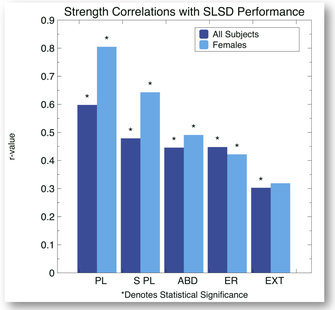

Figure 2: Univariate Correlational Analysis

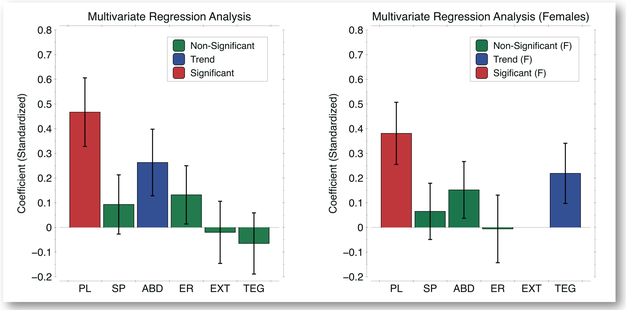

Figure 3: Multivariate Linear Regression Analysis of Correlations Between Strength Tests and SLSD Performance

DISCUSSION AND CONCLUSIONS

To our knowledge this study is the first to correlate trunk strength to performance on these single-leg assessments. Trunk strength, as measured by plank time, is more predictive of maximum step-down repetitions in males and females than hip strength, which had previously been connected with step-down performance.[8]

The connection between weak hip muscles and lower extremity injury has been well studied, and the connection between trunk control and lower extremity injury is becoming more clearly understood.[3, 11] Previous research suggests that weak hip strength can lead to increased hip adduction, femoral internal rotation, and dynamic valgus of the knee, placing the lower extremity, and particularly the ACL, at risk for injury. Ligamentous knee injuries have also been associated with poor trunk control.

As we gain more knowledge about potentially dangerous knee movements and their "mechanistic connection" with the hip and core[3] we further understand the essential need for effective trunk control and core strength screening strategies. Single leg squats and step-downs have been described as screening tools for hip strength, but their association with trunk strength has not previously been studied.

Limitations of this study include the fact that the study population is one of convenience, and does not represent a single age group, sport, or athlete profile. Lack of standardized trunk strength and control measurements in the literature is another limitation. However, good data exists to validate the use of prone bridging tests such as the plank test for strength measurements.[10] Additionally, this study did not directly examine the correlation between SLSD performance and injury risk.

In conclusion, the Single Leg Step-Down test has many characteristics of an ideal injury prevention and RTP screening tool, and can be used to identify individuals with weak hip and trunk strength.

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