SINGLE-LEG DYNAMIC STABILITY IN FIT, YOUNG ADULTS: LOWER EXTREMITY STRENGTH AND CORE STRENGTH AS PREDICTORS

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INTRODUCTION

Dynamic stability describes the process of transitioning from movement to a quiet, standing posture. Various measures, based on the diminishing fluctuations in ground reaction forces (GRF) and center-of-pressure (COP) trajectories, are often used to assess this transition [1]. Sports medicine clinicians have assessed dynamic stability in athletes with compromised joints (e.g., ACL injuries, ankle instability), but the influence of lower extremity strength has not been examined [2].

Overall muscle strength, especially core and lower extremity muscle strength, is thought to enhance stability and reduce the risk of joint injury [3]. Unfortunately, stability is used in a variety of applications with different definitions that depend on a person's perspective. For example, gerontologists may use stability to help predict the potential for independence, while sports medicine specialists may focus on an athlete's rehab from a lower extremity joint injury. Regardless of the perspective, improving muscle strength is thought to enhance stability of the entire body and lower extremity joints.

The purpose of this experiment was to identify whether lower extremity muscle strength and core strength was predictive of single-leg dynamic stability among young, fit adults. It was hypothesized that stronger individuals would be more stable.

METHODS

Thirty-eight people volunteered for this study (18 men; 20 women). All participants were young, healthy, and active (age = 21.8 ± 2.4 yrs, mass = 73.3 ± 13.1 kg, height = 172.9 ± 7.9 cm). At the beginning of a single test session, the experimental protocol was explained and a written informed consent was obtained. Demographic and anthropometric data were collected in addition to a self-assessment of fitness and some details about the frequency, duration, and intensity of weekly workouts.

Participants performed a brief, 10-15 minute warm-up (e.g., walk, stretch, low-intensity exercise). Four dynamic, single-leg postural stability trials were collected: two from a forward hop; two from a medially directed hop. Ground reaction force (GRF) data were collected for 20 s at 100 Hz. A stability index (SI), based on root-mean-square values, was computed for both the medial-lateral (ML) and anterior-posterior (AP) GRF components [1]. The SI was calculated over 3 seconds, beginning 0.5 s after impact to avoid inclusion of the impact GRF peak.

Lower extremity muscle strength was determined with an isokinetic dynamometer. Maximal, isometric efforts were measured for: knee flexion; knee extension; ankle plantarflexion; and ankle dorsiflexion. Four tests of core muscle endurance were also performed in a randomized order: 1) isometric trunk flexor posture; 2) isometric trunk extensor posture; 3) the "trunk side plank" exercise on the left side; 4) the "plank" exercise on the right side. Participants were required to hold these positions for as long as possible [4].

Stepwise multiple regression was used to evaluate the predictive power of strength measures for dynamic stability. Lower extremity strength measures were normalized to body weight and core muscle endurance was expressed as a duration.

RESULTS AND DISCUSSION

Six of the stepwise regression models were statistically significant with back extensor muscle endurance identified as the most frequent predictor variable. No secondary, predictor variables were identified after the primary one shown in Table 1. The regression model with the highest amount of explained variance is shown in Figure 1. The stability indices (SI) for the AP direction of the medial hops (right and left) produced no significant predictors (not shown in Table 1).

Table 1: Dependent variables (stability indices) and the significant predictor variable for each regression model.

Dep Var	Predictor	r	adj r^2	*p*-value
LF-SI-AP	Core-Ext	-.36	.11	.025
LF-SI-ML	Core-Ext	-.32	.08	.047
LM-SI-ML	LtKneeExt	-.34	.09	.034
RF-SI-AP	Core-Ext	-.38	.12	.019
RF-SI-ML	Core-Ext	-.47	.20	.003
RM-SI-ML	Core-Ext	-.35	.10	.029

L=left; R=right; F=forward; M=medial; SI-AP=stability index based on AP GRF; SI-ML=stability index based on ML GRF; Core-Ext=back extensor endurance; LtKneeExt=normalized knee extensor strength.

A lower SI indicates better dynamic stability and a longer endurance time for back extensor muscles is related to greater strength [4]. Therefore, the direction of the relationships between those variables in the five significant models shown in Table 1 was expected. (i.e., lower stability indices associated with longer endurance times).

Although one significant regression model included a lower extremity strength measure (for LM-SI-ML), it was surprising that no other leg strength measures were included. Our expectation was based on the findings of worse dynamic stability in subjects with functionally compromised ankle and knee joints [2]. Muscle strengthening is commonly prescribed to overcome such joint deficiencies, but our results did not show greater joint strength being associated with better dynamic stability. Overall core strength is frequently proposed as an important element of overall fitness and our results clearly show that back extensor muscle strength is the most important contributor to dynamic stability. These results are limited to young, active people and future work should focus on groups representing different ages and activity levels.

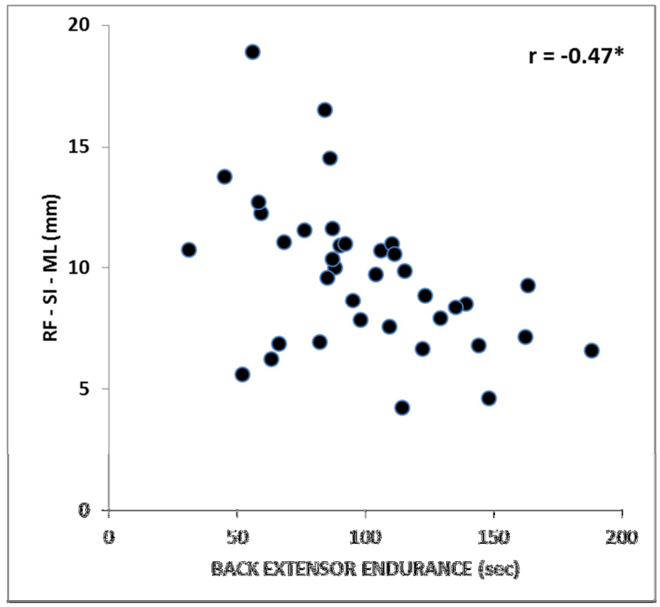

Figure 1: Scatterplot of extensor muscle endurance and the medial-lateral stability index (SI) for a right-footed, forward landing. **p*<.05

CONCLUSIONS

After considering muscle strength at the knee and ankle, as well as musculature associated with the body's core, the endurance of back extensor muscles was the best predictor of dynamic stability. This conclusion was reached for multiple conditions (i.e., right and left leg; two different directions of movement-landings).

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