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

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INTRODUCTION

Postural stability, particularly static whole-body stability in older adults, has received considerable attention in the research literature. Whole-body stability in younger, athletic populations has received less attention, primarily because typical static, two-legged postural assessments do not sufficiently tax a younger person's overall stability.

Overall muscle strength, especially core and lower extremity muscle strength is thought to enhance stability and reduce the risk of injury [1]. 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 [2]. King et al. [3] showed a moderately strong relationship between postural stability of single-leg standing and the ratio of lower extremity strength and whole body moment of inertia in adolescents. In older adults, the relationship between lower extremity strength and postural stability is not very clear [4].

The purpose of this experiment was to identify whether lower extremity muscle strength and core strength was predictive of single-leg static 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, body height = 172.9 cm ± 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 then performed a brief, 10-15 minute warm-up (e.g., walk, stretch, low-intensity exercise). Static, single-leg postural stability trials were collected on each leg and for two floor conditions (hard surface and soft surface). Ground reaction force (GRF) data were collected for 20 s at 100 Hz and the center of pressure (COP) coordinates were calculated for analysis. COP mean velocity, 95% confidence ellipse area, and 95% power frequency were calculated [5].

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 [6].

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

RESULTS AND DISCUSSION

Stepwise regression models for the dependent variable COP mean velocity were statistically significant for each foot-floor condition (see Table 1). Other dependent variables did not yield a significant regression model (95% confid. ellipse area and 95% power freq.). Back extensor muscle endurance was identified as the predictor variable for the left leg-hard surface condition, whereas normalized ankle dorsiflexor strength was identified for the other three conditions.

Table 1: Foot-floor conditions and stepwise regression results for the dependent variable COP mean velocity.

Condition	Predictor	r	adj r²	p-value
Left-Hard	Core-Ext	-.33	.10	.034
Right-Hard	RtAnkleD	+.43	.19	.007
Left-Soft	LtAnkleD	+.35	.10	.033
Right-Soft	RtAnkleD	+.38	.12	.018

Core-Ext=back extensor endurance; Lt=left; Rt=right; AnkleD=normalized ankle dorsiflexor strength.

As shown in Figure 1, a lower COP mean velocity indicates better static stability and a longer endurance time for back extensor muscles is related to greater strength [6].
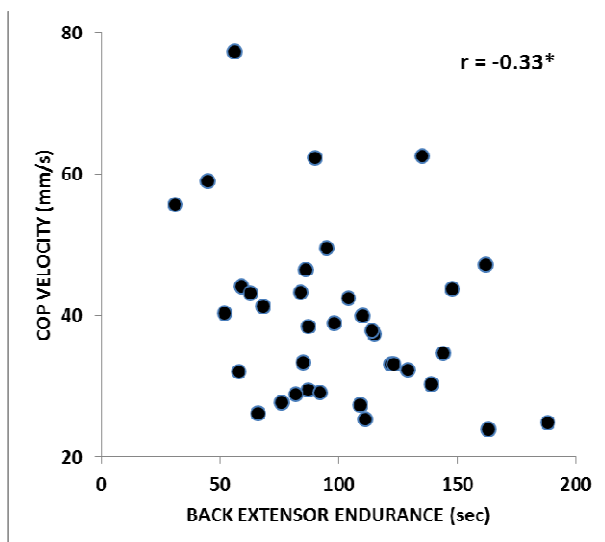

Figure 1: Scatterplot of back extensor muscle endurance and COP velocity for a left-footed, hard surface condition. *p<.05

Therefore, the direction of the relationships between those variables in the first model shown in Table 1 was expected. (i.e., lower COP mean velocity associated with longer endurance times).

Upon closer examination, the three regression models that included ankle dorsiflexor strength as a significant predictor had an outlier that skewed the choice (See Figure 2). In addition, the positive correlation was opposite of our prediction.
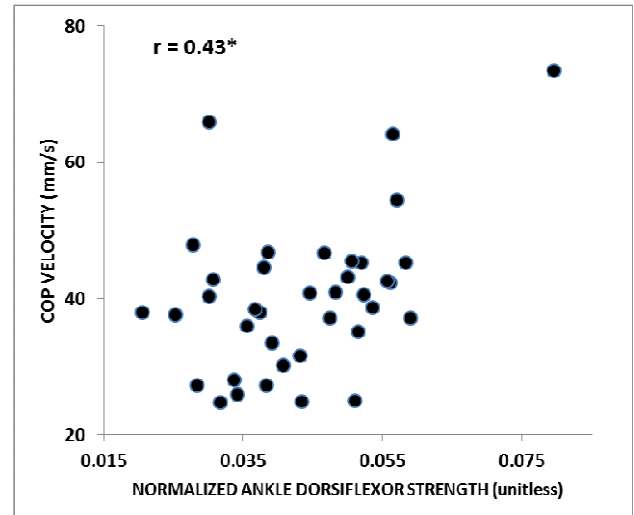

Figure 2: Scatterplot of normalized ankle dorsiflexor strength and COP velocity for a right-footed, hard surface condition. *p<.05

Based on the results of the present experiment, the relationship between lower extremity strength and postural stability in a group of young, active people is unclear. This is similar to findings with older, less active adults [4]. The back extensor endurance time offers promise as a predictor of single-leg stability, but the amount of variability explained is modest.

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