LOWER EXTREMITY STRENGTH PLAYS ONLY A SMALL ROLE IN DETERMINING THE MAXIMUM RECOVERABLE LEAN ANGLE IN OLDER ADULTS

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INTRODUCTION
The susceptibility of older adults to falling has been associated with diminished ability to perform stepping responses following large postural perturbations. When released from a forward-leaning position and instructed to restore stability using a single step, healthy older adults have a significantly smaller maximum recoverable lean angle than young subjects (Thelen et al., 1997). Further, compared to older men, older women have significantly smaller maximum recoverable lean angles (Wojcik et al., 1999). These age- and gender-related findings were attributed to the maximum speeds attained by the lower extremities during the step.

It is reasonable to expect that lower extremity muscle strength and power contribute to the lower extremity speed during this task, and, therefore, maximum recoverable lean angle. Thus, the purpose of this study was to determine the extent to which lower extremity strength and power contribute to the maximum recoverable lean angle in older adults.

METHODS
The maximum recoverable lean angle was determined for 56 older women and men (>65 years). Subjects, protected from falls to the ground by a safety harness system, were released without warning from a statically unstable forward lean by means of a remotely controlled electromagnetic support system. Upon release, the subjects were instructed to take a single step to regain their balance. Subjects performed two consecutive trials at each of 5, 10, 15, and 20 degrees of forward lean unless two failed recoveries occurred at a given angle of lean. A recovery was classified as a failure if, following the initial step, the arms came unfolded, the stepping foot moved entirely from the position at which it was initially placed after the recovery, the entire non-stepping foot moved, or the body was completely supported by the dynamic ropes.

Maximum recoverable lean angle was determined as the included sagittal plane angle between the vertical and the axis from the ankle joint to the center of mass of the body.

Maximum isometric strength was measured for the ankle, knee and hip (Pavol et al., 2002).

The initial statistical approach consisted of a discriminant analysis performed on a subset of the subjects. Subjects were separated into one of two groups based on whether the maximum recoverable lean angle placed the subject in either the lowest or highest quartiles of the sample. The maximum isometric
moment values for which the between group differences were significant were entered into a discriminant analysis to determine the extent to which the variable set could correctly classify these subjects. Lastly, a stepwise regression procedure was conducted to predict maximum recoverable lean angle using the variables included in the discriminant analysis procedure. The stepwise regression was conducted using all of the subjects in the sample (n=56).

RESULTS

The difference between the maximum recoverable lean angle of those subjects who fell at or below the 25th percentile was 11±2degrees (n=14) and those subjects at or above the 75th percentile was 20±3 degrees (n=14) was significant (p<0.001). Notably, and in contrast to the findings of Wojcik et al. (1999) the gender-based differences were not significant (p=0.635).

Only maximum isometric hip extension moment failed to achieve a significant difference between the subjects in the lowest and highest quartiles of maximum recoverable lean angle (p=0.095). The stepwise discriminant analysis to classify subjects into the lowest and highest quartile of maximum recoverable lean angle reduced the remaining variable set to maximum isometric plantarflexion moment (Wilk’s lambda=0.738, p =0.005)). The discriminant function correctly classified 68 percent of the subjects.

The stepwise regression procedure conducted to predict maximum recoverable lean angle as a function of maximum isometric plantarflexion moment and applied to the entire sample of older adults was significant (p<0.001) and accounted for 16 percent (adjusted) of the shared variation.

DISCUSSION

Generally, lower extremity strength appears to be an important determinant of maximum recoverable lean angle of healthy older women and men. The particular measure of strength identified as the key determinant was surprising. In light of previous research using this protocol that has indicated the importance of lower extremity speed to performance of this task (Thelen et al., 1997; Wojcik et al., 1999; Wojcik et al., 2001), the hip extensor muscles and, possibly the knee extensor muscles were expected to emerge as important contributors to performance.

The fact that 84 percent of the variance was not accounted for suggests key contributions to performance of other, non-strength related variables. One such variable for a lower extremity, time critical task is lower extremity coordination (Tomioka et al., 2001).

REFERENCES


ACKNOWLEDGEMENTS

Supported by NIH RO1AG10557 (awarded to MDG)