THE TEST-RETEST RELIABILITY OF COMPENSATORY STEPPING THRESHOLDS OF YOUNG ADULTS

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INTRODUCTION

Falls are the leading cause of accidental injury for older adults [1]. Identifying sensitive, reliable fall-risk assessments will improve the prescription of interventions. The ability to limit steps in response to a disturbance is reduced with old age, especially for those with a recent fall history [2-6]. This evidence suggests that compensatory stepping thresholds, or the minimum disturbance magnitudes that elicit single and multiple steps, may prospectively identify older-adult fallers. Clinically useful assessments, however, must be reliable. The purpose of this study was to initially evaluate the test-retest reliability of compensatory stepping thresholds by assessing young adults.

METHODS

Fifteen healthy, young adults (10 women / 5 men, age: 29 ± 7.5 years, height: 172.8 ± 8.8 cm, mass: 67.5 ± 13.8 kg) volunteered for this IRB-approved study. All participants provided written, informed consent prior to data collection.

Subjects visited the laboratory twice, with six to eight days between visits. At each visit, subjects were outfitted with a harness attached to an overhead rail. As subjects stood on a microprocessor-controlled treadmill (ActiveStep®, Simbex, Lebanon, NH), 400 ms surface translations were delivered. The velocity profiles were triangle waveforms with peak velocities of 0.1-3.2 m/s, resulting in displacements of 2-64 cm.

Each visit consisted of three progressive series of disturbances to determine the following thresholds:

- **Anterior and Posterior Single-Stepping Thresholds.** Subjects were instructed to “try not to step” in response to anterior and posterior disturbances. Initial foot placement was at a comfortable width.
- **Anterior and Posterior Multiple-Stepping Thresholds.** Subjects were instructed to “try to take only one step” in response to anterior and posterior disturbances. Initial foot placement was at a comfortable width.
- **Lateral Single-Stepping Thresholds.** Subjects were instructed to “try not to step” in response to left and right disturbances. Feet were placed together, side-by-side. Thresholds were identified for the skill side (i.e. kicking limb) and stability side (i.e. non-kicking limb).

Within each progression, the direction (i.e. direction of the fall) and timing of disturbances were randomized. If a subject responded as instructed, the displacement was increased by one “level” for the next disturbance in that direction. Levels were incremented by 2 cm and 4 cm displacements for single- and multiple-stepping thresholds, respectively. The subject response was observed and recorded by a single investigator. Thresholds were defined as the disturbance displacement that elicited a failed response to four trials. Failed responses were due to stepping against instructions or support from the safety harness. The disturbance progression continued until thresholds in each direction were established.

The test-retest reliability of thresholds was assessed using intraclass correlations (ICC 2,1), Bland-Altman plots, and the true score 95% confidence interval [7,8].

RESULTS AND DISCUSSION

Stepping thresholds exhibited excellent agreement (ICC > 0.80, Figure 1). The anterior single-stepping threshold may have been less reliable (ICC = 0.65).
because multiple available response strategies (ankle, knee, hip, mixed) increased inter-trial variability [9]. Repeatability was not analyzed for the anterior multiple-stepping threshold because nine subjects recovered from the largest disturbance in one step.

True single-stepping threshold confidence intervals were smaller than ±3.8 cm. A change of three levels would be considered real in all cases. The true posterior multiple-stepping threshold confidence interval was ±8.8 cm. A change of four levels would be considered real in all cases. For every decade of aging, the anterior single-stepping threshold decreases by about 1 cm, and the posterior multiple-stepping threshold decreases by about 5 cm [2,10]. Therefore, stepping thresholds are sensitive to the detrimental effects of aging that occur over 2-4 decades of life.

CONCLUSIONS

Compensatory stepping thresholds are reliable measures when assessing young adults. The ability of these measures to reliably and sensitively predict falls by older adults has yet to be determined.

REFERENCES

1. CDC WISQARS  www.cdc.gov/injury/wisqars/index.html

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Figure 1: Bland-Altman plots of all thresholds.