A Novel Task to Decrease Step Width Variability in Older Adults

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ABSTRACT

Walking is the most common fall-related activity among older adults [1]. Also, older adults experience greater step width variability when walking [2]. Importantly, increased step width variability during walking has been found to be a strong predictor of fall risk and incidence [3]. Therefore, an intervention for reducing increased step width variability may consequently reduce fall risk for older adults.

In the present study we propose that lateral stepping training program improves walking in older adults by reducing the increased step width variability to normal values. Therefore, the purpose of the present study is to determine the effect of a six-week lateral stepping training program on step width variability

MATERIAL/METHOD

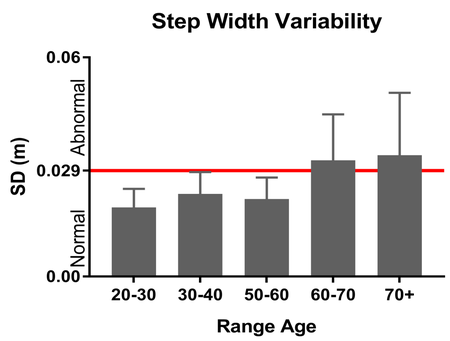

Fig. 1: Step width variability (SD: standard deviation) during forward walking for young and older adults according to our literature review. The horizontal red line shows the upper threshold that differentiates older adults aged above 60 years with increased step width variability and higher fall risk from the older adults that have step width variability like the young adults.

To determine an upper threshold of normal step width variability, we performed an extensive computerized literature search in PubMed, Google Scholar, and Science Direct up to October 2017. The search was limited to English language and full extended original articles. To be eligible for inclusion, studies had to meet the following criteria: i) participants were healthy, ii) step width variability was measured by force plate, optical system, pressure mat or an instrumented walkway, iii) trials were performed on a treadmill or overground, and iv) participants selected their comfortable walking speed. The values of step width variability identified through this extensive search are plotted against age ranges (**Fig. 1**). Very limited data was found for ages 40-50 and thus this range was not included.

From the extracted data we identified 0.029 m as the upper threshold for normal step width variability. This threshold was used in the present study to differentiate older adults aged with increased step width variability from those who have a step width variability similar to young adults.

RESEARCH

Community-dwelling older adults aged over 65 underwent an initial screening, walking for three-minutes at their self-selected comfortable walking speed (baseline speed) on a treadmill. Two older adults (1f and 1m; age 69 and 81 yrs.; height 1.51 and 1.58 m; mass 66.8 kg and 63.04 kg, respectively) with abnormal levels of step width variability (> 0.029 m), and two older adults (1f and 1m; age 81 and 82 yrs.; height 1.54 and 1.78 m; mass 64.4 kg and 80.7 kg, respectively) with normal levels of step width variability (< 0.029 m) were identified and underwent our lateral stepping training three times a week for six weeks. Participants stepped laterally across a 10m section on an indoor track, changing direction at the ends thus alternating lead and lag legs. In addition, three minutes of lateral stepping was alternated with at least one minute of rest. Each session consisted of 30 minutes of lateral stepping. Following the six weeks of lateral stepping training, the participants' step width variability was measured again (**Fig.2**).

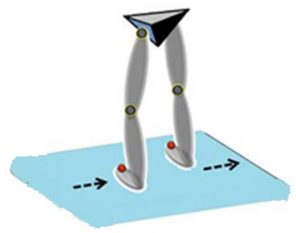

Fig. 2: Body is oriented orthogonal to typical forward walking during lateral stepping gait to alter the influence from passive mechanics of motion.

During the data collection on the treadmill, participants wore retroreflective markers on the top of the second metatarsal (MT) joint and posterior heel. Continuous motion of feet was tracked by a 17-camera high-speed motion capture system (Motion Analysis Corp.) at 100 Hz. The raw 3D marker trajectories were smoothed using the GCVSPL algorithm [4]. Foot position was calculated as the center point between a heel and MT marker (Visual 3D, C-Motion, Germantown, MD). Step width was determined as the medial-lateral distance between the locations of the sequential left and right mid-footsteps. Step width variability was calculated as the standard deviation of step width.

RESULTS

The six-week lateral stepping intervention decreased step width variability to normal levels in the two older adults that were identified as having abnormal levels (**Fig. 3.A**), and their new self-selected comfortable walking speed after the six-week training was greater than their baseline walking speed (**Fig. 3.B**). Moreover, walking speed improved in the older adults with normal levels of step width variability (**Fig. 3.D**), while their step width variability stayed within the normal levels.

These results demonstrate the feasibility and, most importantly, the potential of our six-week lateral stepping intervention to reduce abnormal step width variability to normal levels and increase gait speed.

RESULTS

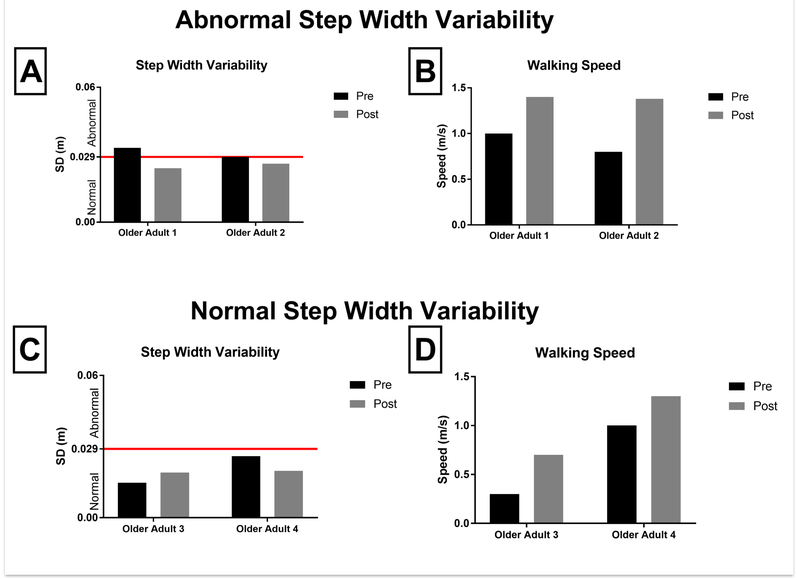

Fig. 3: The six-week lateral stepping intervention decreased step width variability to normal levels in the two older adults that were identified as having abnormal levels (A). Moreover, the new comfortable walking speed that the older adults chose after the six-week training was greater than the baseline walking speed (B). Walking speed also improved in the older adults with normal levels of step width variability (D). Their step width variability stayed within the normal levels (SD = standard deviation; Pre = Pre-intervention; Post = Post-intervention).

CONCLUSION

The lateral stepping training results in reduced step width variability during forward walking in older adults. Lateral stepping exercise program is simple, time and cost effective and can start from day one at home without the need for supervised training sessions.

We proposed that community-dwelling older adults with step width variability > 0.029 m will benefit more from the lateral stepping gait intervention in the present study by reducing their increased step width variability to normal values.

REFERENCES

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