NON-STEPPING BALANCE RECOVERY CAPABILITY DIFFERS BETWEEN YOUNG AND OLDER ADULTS

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INTRODUCTION

It is well-documented that older adults have a higher risk for falling than young adults. One contributing factor to this higher risk of falling is thought to be an impaired ability to recover balance after a postural perturbation. Older adults have consistently exhibited an impaired ability to recover balance after a wide range of postural perturbations.

Mackey and Robinovitch [1] determined the largest static angle from which young and older women over 65 could recover balance upon release when using the so-called ankle strategy. Older women exhibited a 19.6% smaller maximum lean (13.1 degrees) compared to young women (16.3 degrees). Constraining balance recovery to the ankle strategy is a fairly significant constraint on body kinematics, particularly when older adults are known to exhibit greater hip motion during non-stepping balance recovery [2]. The purpose of this study was to investigate age differences in non-stepping balance recovery capability without constraining movements to the ankle strategy. As such, participants could bend at the hips, knees, ankles, or raise portions of feet off the floor to maintain balance.

METHODS

Three groups of adults completed the study including five young adults (age = mean 22.8 ± SD 2.6 years), six community-dwelling older adults (age = 73.2 ± 2.2 years), and five assisted-living older adults (age = 85 ± 6.5 years) from a local nursing home. All participants were able to stand unassisted. The study was approved by the local Institutional Review Board, and written consent was obtained from all participants prior to participation.

Participants stood on a pneumatic, instrumented, moving platform (PIMP) that translated 0-0.15 m forward or 0-0.25 m backward in ~350 ms (Figure 1). Forward displacements elicited a backward loss of balance by participants, and backward displacement elicited a forward loss of balance by participants. The time over which the PIMP translated was fairly constant (350 ms), and the translation distance was modulated by increasing the peak translation speed (e.g. 0.4 m/s for a translation distance of 0.08 m, or 1.1 m/s for a translation distance of 0.19 m). A potentiometer was used to measure displacement of the PIMP during each trial.

Figure 1: Photograph of PIMP.

Balance recovery capability was quantified by determining the maximum forward and backward PIMP displacement the participants could withstand without stepping. Participants stood barefoot on the PIMP with their feet approximately shoulder-width apart, eyes open, and while looking straight ahead. They were instructed to remain relaxed, try their best not to step, and remain standing still after the perturbation. The first trial began with the PIMP moving approximately 0.02 m backward. After a successful (i.e. non-stepping) trial, another trial was performed with the displacement increased approximately 0.01 m. After an unsuccessful trial (i.e. the participant stepped or required assistance by a spotter), another trial was performed at the same

displacement. This process was repeated until three unsuccessful trials occurred at the same platform displacement. Both forward and backward platform translations were presented in a random order to prevent anticipation of translation direction, and to simultaneously determine the maximum displacement that the participants could withstand without stepping in both directions.

The maximum forward and maximum backward perturbation distance from which balance could be maintained without stepping (i.e. maximum forward distance and maximum backward distance, respectively) were compared between groups using a Kruskal-Wallis one-way analysis of variance by ranks, and a significant effect of group was followed by multiple comparisons between each pair of groups using a Wilcoxon signed-ranks test. A significance level of $p<0.05$ was used, and analysis was performed using JMP v10 (SAS Institute, Inc., Cary, NC).

RESULTS AND DISCUSSION

The maximum forward distance, which elicited a backward loss of balance, was 60% and 54% smaller in the assisted-living older adults compared to young adults (p=0.011) and community-dwelling older adults (p=0.007), respectively, but did not differ between the young adults and community-dwelling older adults (p=0.302). The maximum backward distance, which elicited a forward loss of balance, was 61% and 47% smaller in the assisted-living older adults compared to young adults (p=0.012) and community-dwelling older adults (p=0.008), respectively, and was 27% smaller among the community-dwelling older adults compared to the young adults (p=0.027: Figure 2).

Our results are consistent with prior studies on non-stepping balance recovery in that older adults exhibited compromised balance recovery capability compared to young adults [1]. Our results also showed greater impairment in older adults from an assisted-living center compared to those who were community-dwelling.

One limitation of this study is that, as in earlier work, constraining balance recovery to a non-stepping strategy when such a constraint is possible, but not typical, reduces the external validity of the study. However, it is possible that the same neuromuscular factors that contribute to the age differences in non-stepping balance recovery also contribute to age differences in balance recovery without any constraints. Moreover, this constraint provides experimental control that improves internal validity, and can facilitate planned future modeling efforts.

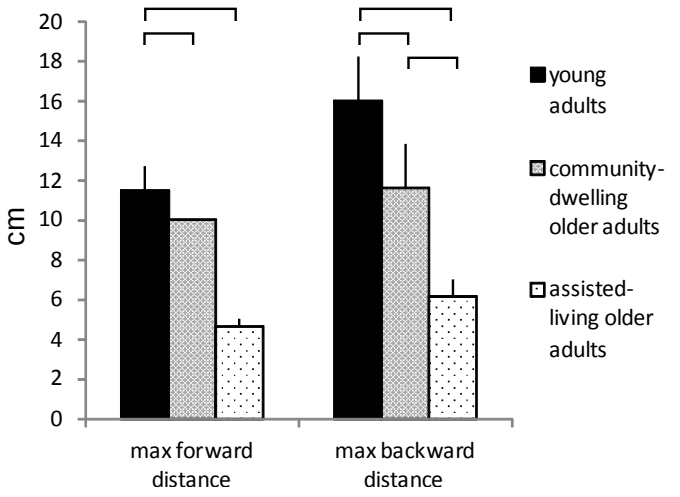

Figure 2: Median values of maximum forward and backward distance across all three groups. Error bars represent interquartile range. Bars at top indicate statistical difference between groups.

CONCLUSIONS

In conclusion, the ability to maintain balance without stepping after a brief support surface perturbation was impaired up to 61% among older adults living in an assisted-living center and up to 27% among community-dwelling older adults compared to young adults. Impaired balance recovery likely contributes to higher fall rates among these individuals.

REFERENCES

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