Older Adult Frontal Plane Balance During Pre-Planned and Late-Cued Turns

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Summary

Falls are a leading cause of injury in older adults and falls during turns are more likely to result in a hip fracture. Compared to straight-line gait, turning tasks lead to larger frontal plane angular momentum range and smaller lateral distance minima. Person-specific strategies did not all follow these group trends in ways that suggests that some older adults utilized protective strategies during challenging turning tasks.

Introduction

Falls are a leading cause of injury in older adults [1] and falls during turns are 7.9 times more likely to result in a hip fracture [2]. This study looks at two frontal plane balance metrics during walking and turning: frontal plane angular momentum (H_f), the measure of the body's rotational motion around the whole-body center of mass, and lateral distance (LD), the frontal pane distance between the whole-body center of mass and the closest lateral edge of the base of support. Based on previous research with young adults [3], we hypothesized that older adults will have 1) larger H_f range during turning tasks than straight-line gait, 2) larger H_f range during late-cued turns than pre-planned turns, 3) smaller LD minima during turning tasks than straight-line gait, and 4) smaller LD minima during pre-planned turns than late-cued turns.

Methods

16 healthy older adults (14 f; age 73 ± 4.93 years; mass 70.8 ± 11.5 kg; height 1.63 ± .078 m) provided informed consent and passed clinical and cognitive assessments. A 13-segment whole-body kinematic model [4] was built using optical motion capture data (OptiTrack, USA). A grocery store aisle intersection was simulated with a taped T-shaped walkway, including a 10 m straight walkway with a 90° turn in the center leading to a 5 m walkway. Three tasks were performed 10-14 times: straight-line gait, 90° pre-planned left turns, and 90° late-cued left turns visually cued by a display screen at the end of the intersection (50% chance of turning). Eight participants did not complete late-cued turns due to lack of time. H_f was normalized to a dimensionless form [3]. LD was calculated as the distance from the center of mass to the closest lateral edge of the base of support [3]. LD is negative when the center of mass passes laterally to the lateral edge of the foot. H_f range and LD minima were found during steady-state straight-line gait, and turn phases were defined by a pelvis rotation threshold [3]. Linear mixed models determined differences in H_f range and LD minima across tasks.

Results and Discussion

$\underline{H_f\text{ range}}$: Group level analysis show that H_f range was smaller during straight-line gait than each turning task, but there was no significant difference between H_f range during pre-planned vs late-cued turns, partially supporting our hypotheses (**Fig.1A**). Participant-specific analyses revealed that not all older adults followed the group findings. Some used smaller H_f range during late-cued turns than straight-line gait or pre-planned turns, which was unexpected based on results with younger adults performing the same tasks [3]. These results suggest that smaller H_f range may indicate a protective strategy with older adults during these tasks. Initial explorations found the reduced H_f range statistically associated with measures of increased fear of falling. $\underline{LD\text{ minima}}$: Group level analysis show that LD minima were larger during straight-line gait than each turning task, and larger during late-cued turns than pre-planned turns, supporting our hypotheses (**Fig. 1B**). Participant-specific analysis revealed that no participant statistically demonstrated the opposite behavior from the group findings. More challenging turns may lead to more protective and varied stepping strategies, resulting in more positive LD minima.
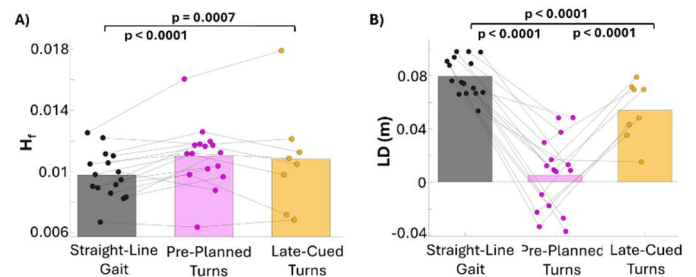

Figure 1: Group level **A)** H_f range and **B)** LD minima. Participant's average value across trials per task indicated by connected dots. Bars indicate group-level average per task.

Conclusions

Group-level results mostly supported our hypotheses. Participant-specific analysis revealed that several participants did not follow expected group-level results, indicating that balance strategies varied across individuals.

Acknowledgments

References

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