

Standing steadiness and variability of older adults on a step ladder

Erika M Pliner¹, Daina L Sturnieks², Kurt E Beschorner¹, Mark S Redfern¹, Stephen R Lord²

¹Department of Bioengineering, University of Pittsburgh, Pittsburgh, PA, USA

²Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Randwick, NSW, AUS

BACKGROUND AND AIMS:

Ladder fall injury rates are highest among older adults [1] and ladder falls commonly occur when the user is standing on the ladder as opposed to climbing [2]. Standing stability measures have been used to classify general fall risk of older adults [3], but the standing stability of older adults performing tasks on ladders has not been investigated. The objective of this study was to investigate the standing stability of older adults at high fall risk while performing the task of changing a light bulb on a household step ladder.

METHODS:

104 older adults participated in the study. Participants completed the short-form Physiological Profile Assessment (PPA) to classify fall risk [3] and climbed to the second step of a household step ladder to change a light bulb. The light bulb height was set to slightly above the participant's head height.

Force plates under the step ladder were used to calculate the center of pressure (COP) between the ground and step ladder [4]. COP parameters during ladder standing (excluding climbing to standing transitions) were extracted to assess participant stability on the step ladder including path length (time normalized), RMS and elliptical area (the area that the COP remains within for 95% of the assessed time) [5]. In addition, the task time (including transitions) was recorded.

The task time and COP parameters were compared between 10 participants with the highest fall risk (z-score ≥ 1.49) and 10 participants with the lowest fall risk (z-score ≤ -0.22) scores in the study.

RESULTS:

Task time was 8.4 seconds (63.9%) longer for the high fall risk group than the low fall risk group. Time normalized path lengths were similar between the low (39.9 mm/s) and high (38.5 mm/s) fall risk groups. The high fall risk group showed an increase in RMS by 18.1% and elliptical area by 44.6% compared to the low fall risk group (Figure 1).

CONCLUSIONS:

Moderate-to-large differences in tasks time, COP RMS and COP elliptical area were observed between low and high fall risk groups when completing a task on a ladder. Larger RMS values and elliptical area indicate more movement away from the average COP location. This suggests high fall risk older adults to be more variable than low fall risk older adults in their standing stability when completing a task on a step ladder. Therefore, standing stability measures of fall risk at the ground level may extended to fall risk during tasks on ladders.

ACKNOWLEDGEMENTS AND FUNDING:

Whitaker International Program.

REFERENCES:

1. Faergemann, C., and Larsen L.B. (2000). *Accident Analysis Prevention*.
2. Faergemann, C., and Larsen L.B. (2001). *J Safety Research*.

3. Lord, S.R, et al. (2003). *Physical Therapy*.
4. Winter, D., et al. (2003). *J Electromyography Kinesiology*.
5. Prieto, T.E., et al. (1996) *IEEE Transaction Biomedical Engineering*.

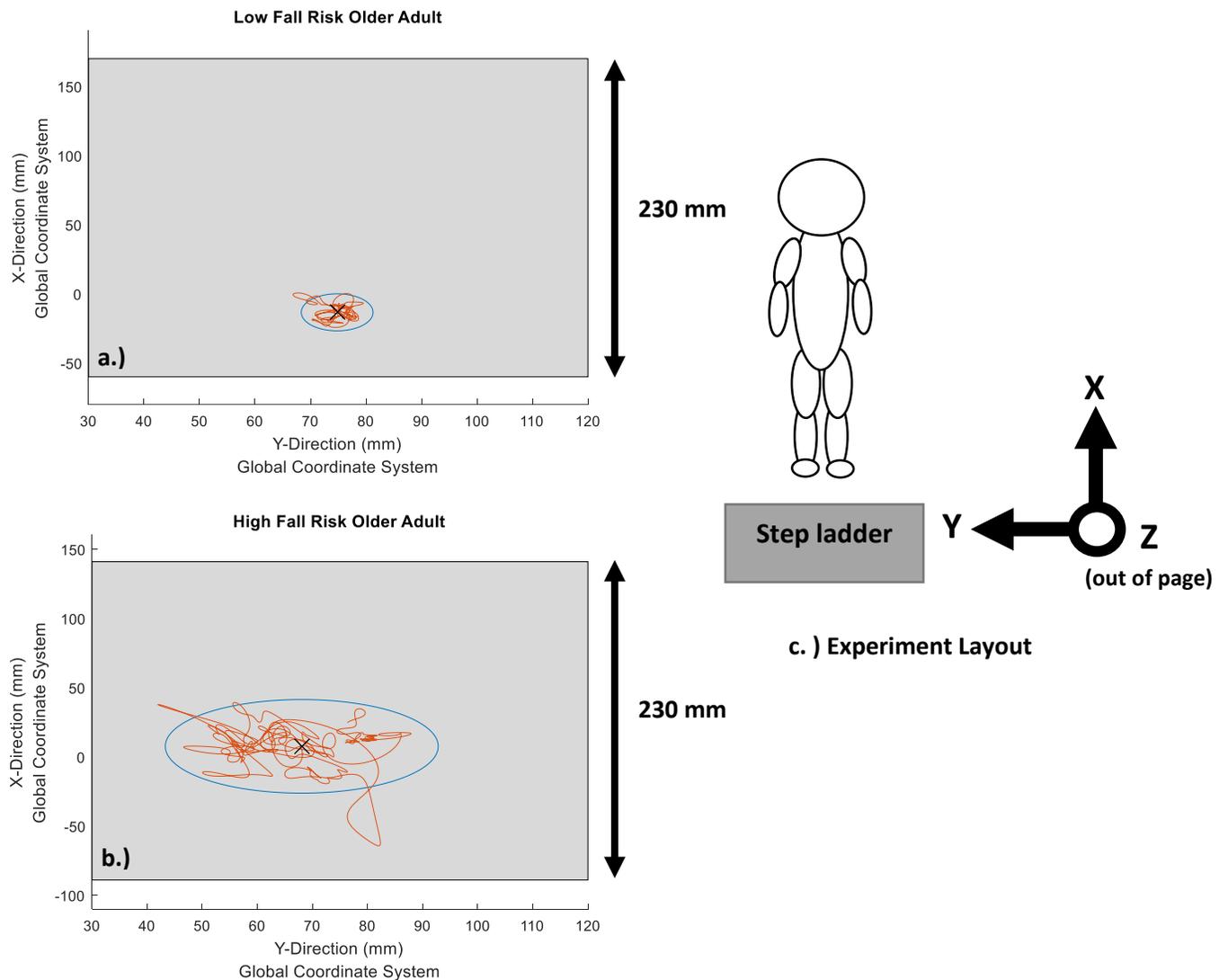


Figure 1: Center of pressure (COP) during stance on the second step of a step ladder for an individual with a low (a) and high (b) fall risk score. The COP is plotted in orange with respect to the global coordinate system. The shaded gray region represents the width of the second step (230 mm) within the global coordinate system. The black 'X' indicates the average COP location. The blue ellipse indicates the area that the COP remains within for 95% of the assessed time. The experiment layout (c) depicts the individual's climbing direction and posture with respect to the global coordinate system.