KINEMATICS OF THE 30-SECOND CHAIR STAND IN HEALTHY OLDER ADULTS VERSUS OLDER ADULTS AT RISK OF FALLS

Katie Crockett1, Joel L. Lanovaz2, Catherine M. Arnold1
1School of Physical Therapy; 2College of Kinesiology, University of Saskatchewan (kle978@mail.usask.ca)

INTRODUCTION
Currently, there are several assessment tools that may be used to predict fall risk. Although risk of falling is multi-factorial, the 30-second chair stand test (30sSTS) is a common screening tool utilized due to the functional relevance and complexity of the sit-to-stand (STS) task, involving all body segments and requiring sufficient joint mobility, lower-limb strength, and balance [1,2]. The protocol for the 30sSTS does not specify strategy other than verifying completion of full sit to full stand motion; therefore, individuals may utilize different kinematic strategies that could contribute to optimal performance. The purpose of this study was to investigate if differences exist in whole body and trunk kinematic strategies in the 30sSTS when comparing healthy older adults and older adults at risk of falling.

METHODS
This study utilized a cross-sectional design with data from two age matched samples – healthy older adults (n=16, 7 women, age 70.8 ± 4.7 years (mean, SD)) and older adults at increased risk of falling (n=16, 12 women, age 72.7 ± 5.0 years). Fall risk was determined by a fall history interview and performance in a standard 3m timed up and go test. All participants were tested on one occasion in the lab for performance in a 30sSTS test. In the 30sSTS, participants sat on a rigid, height adjustable bench (without arm rests and no back support), with arms crossed and were asked to move from sitting to standing as many times as possible in 30 seconds (STSreps). Initial foot placement and chair height were adjusted such that the initial hip and knee angles were standardized at 90° for all participants. An 8 camera motion capture system (F-20, Vicon Motion Systems, CO, USA) was used to collect kinematic data during every trial and whole body centre of gravity (CG) trajectories were calculated. Total body peak linear horizontal and vertical momentum (PLHM and PLVM), timing of PLHM and PLVM, trajectory of the CG at lift-off (CG angle), and trunk angle at liftoff were obtained. Data were calculated for each STS repetition and averaged over all repetitions for each participant. Independent t-tests with Bonferroni correction (α=0.007) were used to determine between group differences for kinematic variables.

RESULTS
Significant differences were found between groups for STSreps, CG angle at liftoff, and PLVM (Table 1). No significant differences were found in PLHM, peak linear momentum timing or trunk angles at lift off (Table 1).

DISCUSSION
We found that older adults at risk of falling perform fewer repetitions during a 30sSTS, but do not adopt a different postural strategy as compared to their healthy counterparts. Similar trunk angles at lift off between the groups shows that the fall risk group did not attempt to reduce the difficulty of the task by leaning farther forward. The lack of difference in the timing of the peak linear momentum also indicates a similar kinematic strategy between the groups.

The primary differences in this study come from PLVM and the trajectory of the CG. The fall risk group had a more horizontal CG trajectory at lift off and a lower PLVM. Adequate strength and coordination are required to generate sufficient upper-body velocity, and hence momentum, prior to lift-off from the chair seat [3]. The ability to generate PLVM in the 30sSTS appears to be decreased in individuals at risk of falling, suggesting a deficit in strength. The lack of difference in PLHM reflects similar findings in other studies showing that horizontal momentum is not sensitive to STS velocity [4].

Performance in the 30sSTS test was linked to fall risk in this study which supports its use as a screening tool. The key components to focus on for intervention training to mitigate fall risk in an STS task still remain unclear, however this study would suggest that lower body strength needed to generate vertical momentum (i.e. quadriceps and hip extensors) may be an important target.

REFERENCES

Table 1: 30sSTS kinematic variables [Mean (SD)], 0% cycle=liftoff, * indicates significant difference at p<0.007.

<table>
<thead>
<tr>
<th>Group</th>
<th>STS Reps*</th>
<th>PLVM (kgms⁻¹)*</th>
<th>PLHM (kgms⁻¹)</th>
<th>PLHM Timing (%cycle)</th>
<th>PLHM Timing (%cycle)</th>
<th>CG Angle (<em>)</em></th>
<th>Trunk Angle (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>13.9 (3.6)</td>
<td>56.9 (18.0)</td>
<td>33.2 (11.5)</td>
<td>52.0 (10.8)</td>
<td>-4.8 (10.2)</td>
<td>32.2 (15.5)</td>
<td>55.2 (6.2)</td>
</tr>
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<td>Fall-risk</td>
<td>9.8 (1.4)</td>
<td>42.3 (9.0)</td>
<td>36.6 (8.8)</td>
<td>47.5 (9.1)</td>
<td>-7.1 (4.5)</td>
<td>18.9 (5.2)</td>
<td>55.0 (5.4)</td>
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