AGE-RELATED CHANGES IN NEUROMUSCULAR OF TRUNK MUSCLES DURING A DYNAMIC LEG LOADING PERTURBATION TASK

D. Adam Quirk¹, Cheryl Hubley-Kozey¹,²
Schools of Biomedical Engineering² and Health and Human Performance¹, Dalhousie, Halifax, Canada, aquirk@dal.ca

INTRODUCTION
Healthy aging is associated with greater risk of falling or developing musculoskeletal injuries. It is speculated that this increased injury rate is due to altered neuromuscular patterns during dynamic loading. The purpose of this study was to determine if there are age-related differences in trunk muscle response to a pelvis stabilization exercise using principal component analysis (PCA).

METHODS
Sixty-one healthy adults volunteered for this study: 49 young (20-50) and 12 old (65+). All participants signed an informed consent form approved by Dalhousie University Health Sciences Research Ethics Board.

Following a series of maximum isometric voluntary contractions (MVCs), participants performed three trials of a dynamic stabilization exercise involving a series of leg lifts from a supine crook lying position. To a 4 second count, they raised the right then left thigh to 90º, followed by left then right lowering to the starting position. Angular displacement of the pelvis was captured using a Flock of Birds™ motion tracker system (Ascension Technologies Corp.) sampled at 50 Hz. Electromyographic (EMG) data collected from 24 trunk muscle sites (abdominal and back extensors) at 1000Hz were full wave rectified and low pass filtered (6 Hz), time normalized to 100% (entire exercise) and amplitude normalized to the appropriate MVC.

EMG ensemble-average waveforms for three trials for each muscle site and subject were entered into a principal component (PC) analysis model, with abdominal and back sites entered separately [1]. Mixed model ANOVA (group, muscle) were conducted for each PC score (α=0.05).

RESULTS
Peak pelvis angular displacement (5.5±2.7º) and time to complete movement (3.6±0.3s), were not different between the two groups. 5 PCs explained 92% of the variance of abdominal sites with significant group and/or group* muscle interactions in PCs 3-5 (Table). For the back sites 2 PCs explained 91.6% of the variance (Table). All PCs demonstrated significant muscle effects (p < 0.001).

DISCUSSION & CONCLUSIONS

Table: Significant main effects and interactions for PC scores for abdominal and back muscles.

<table>
<thead>
<tr>
<th></th>
<th>PC1 abs</th>
<th>PC2 abs</th>
<th>PC3 abs</th>
<th>PC4 abs</th>
<th>PC5 abs</th>
<th>PC1 back</th>
<th>PC2 back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>0.126</td>
<td>0.474</td>
<td>0.347</td>
<td>&lt; 0.001</td>
<td>0.006</td>
<td>0.005</td>
<td>0.226</td>
</tr>
<tr>
<td>Group*Ms</td>
<td>0.626</td>
<td>0.102</td>
<td>0.043</td>
<td>0.248</td>
<td>0.021</td>
<td>0.173</td>
<td>0.057</td>
</tr>
</tbody>
</table>

For the abdominal muscle sites PC3 captured a greater response to the left leg raise at 20-30% where older adults had higher external oblique muscles activity. PC4 captured group difference where older adults had a greater response from 30-55% corresponding with the left leg rise and beginning of left leg lowering. PC5 accounted for a phase shift where older adult activity occurred earlier in the exercise (Figure 1A). For the back muscle sites group differences were found in PC1 which captured the overall higher amplitude response of back muscles sites in older adults (Figure 1B).

Consistent with previous work [1], this study found that older adults had an altered neuromuscular response for abdominal sites even for this low-demand task. Since the amplitude alterations were not systematic throughout the exercise, but were phase specific, they are not likely indicative of age-related strength deficits. These phase responses along with the temporal phase shift may represent an age-related change in amplitude response before leg loading perturbation reflecting increased anticipatory control to stabilize the lumbar spine. A novel finding of this study is the increased back muscle activation in older adults suggesting an age-related antagonist co-activation strategy to stiffen the spine from perturbations or to compensate for age-related reductions in back extensor strength. Together these changes illustrate that older adults have altered neuromuscular response that are not consistent between abdominals and back extensors during this stabilizing exercise.

REFERENCES