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Comparison of leg muscle activity levels during different fitness tests in elderly individuals using surface electromyography

Oddsson J², Oddsson K¹, Weinback A², Godhe M¹,³, Andersson E¹,³,⁴.

¹Laboratory of Biomechanics and Motor Control, Swedish School of Sport and Health Sciences, ²Scandinavian College of Naprapathic Manual Medicine, ³Department of Molecular Medicine and Surgery, Karolinska Institutet, and ⁴Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden
Email: jonina.oddsson@gh.se

Summary
Ten older adults participated in a study measuring activity levels in eight leg muscles during various submaximal and maximal fitness tests for field contexts¹⁴. Several statistically significant differences emerged in comparisons of different fitness tests and maximal exercises, respectively. For example, fast walking gave significantly higher values for all hip and leg muscles compared to normal walking speed.

Introduction
Physical activity, including strength training, is a common form of training for seniors. A desire in certain training and test exercises for older adults is to be able to give specific advice to individuals based on how much different muscles are involved. Knowledge about activity levels for muscles in different test and training tasks can be obtained with electromyographic recordings (EMG). The aim of the study was to investigate in seniors muscle activity levels in eight different leg and hip muscles during some fitness tests and maximum voluntary contractions (MVC).

Methods
Ten seniors (women and men, 66-89 years, who regularly participate in supervised exercise at least once a week) performed six physical field context tests (primarily for the hip and leg muscles)¹⁴. We also recorded 16 static maximum voluntary contractions (MVC), designed to maximally activate the gluteus maximus (GM), lateral hamstrings (BF—biceps femoris-caput longum, medial hamstrings (SEMI—semitendinosus/semimembranosus), rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), gastrocnemius (GASTR) and soleus (SOL) muscles. Surface EMG activity levels were analyzed regarding mean amplitude (µV) in each exercise. The EMG levels for each exercise, muscle and individual were expressed as a percentage of the highest measured value found in any of the assessed MVC exercises. Mean values (±1 Standard Deviation, SD) were calculated for all participants' normalized EMG values. Statistically significant differences between the recorded exercises for each muscles’ activity level (expressed as a percentage of MVC level) were calculated via one-way ANOVA followed by post-hoc Fisher LSD-test (p <0.05).

Results
High activity levels (% of MVC), were noted in a number of exercises. An example was a dominance in the muscles of the front thigh during the exercise "wall sit", i.e. a static sitting position without a chair, with 90 ° in the hip and knee joint. Here, the mean amplitude was for RF 42%, VL 50% and VM 49%, whereas the levels of the hip extensors were significantly lower, GM 9%, BF 7% and SEMI 6%, and the activity for the lower leg muscles SOL was then 24% and for GASTR 12%. In the 10-meter-walking-test², which was performed both at a self-selected calm normal walking pace and walking as fast as possible, a significantly increased activity (±15-35% higher values) was seen in all registered muscles, in the faster execution (p<0.05). The mean EMG-levels in the fastest versus the normal walking speed were for GM: 25% vs 11%, BF: 36% vs 21%, SEMI: 41% vs 21%, RF: 57% vs 22%, VL: 34% vs 17%, VM: 50% vs 23%, GASTR: 53% vs 31%, SOL: 66% vs 48%. All three quadriceps muscles had obvious activity in the two tests “Five-repetition sit-to-stand” and “Timed-up-and-go” (TUG), while within the calf muscles the latter test, TUG, revealed higher activity (Tab. 1). The muscles within a synergy could show their highest EMG levels in separate MVC tasks, in which factors of importance could be i.e. how and where the external resistance was given in the MVC task, and if nearby joints were flexed or extended.

Conclusions
Several statistically significant EMG activity differences emerged for the muscles in the tests. It may be of interest to see which fitness tests result in higher respectively lower muscle activation for evaluations of leg strength and function in different health test contexts. The results might be useful in various gym and clinical settings to give specific advice to older adults regarding how much different muscles are involved in certain training and test exercises.

References

Table 1. Mean EMG-amplitude values (± 1 SD) in percentage of MVC in two of the assessed field-context fitness tests designed for seniors.

<table>
<thead>
<tr>
<th>Fitness tests</th>
<th>GM</th>
<th>BF</th>
<th>SEMI</th>
<th>RF</th>
<th>VL</th>
<th>VM</th>
<th>GASTR</th>
<th>SOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five-repetition sit-to-stand²</td>
<td>22 ±17</td>
<td>18 ±11</td>
<td>19 ±14</td>
<td>38 ±13</td>
<td>39 ±14</td>
<td>39 ±16</td>
<td>15 ±7</td>
<td>26 ±10</td>
</tr>
<tr>
<td>TUG-Timed up &amp; go, 3m from a chair &amp; back²³</td>
<td>20 ±14</td>
<td>25 ±9</td>
<td>29 ±11</td>
<td>36 ±8</td>
<td>30 ±12</td>
<td>36 ±12</td>
<td>40 ±20</td>
<td>59 ±20</td>
</tr>
</tbody>
</table>

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