Effectiveness of Exercise Programs for Management of Shoulder Pain in Manual Wheelchair Users with Spinal Cord Injury: A Systematic Review
Kimberle A. Cratsenberg, SPT, Cassandra E. Deitrick, SPT, Taylor K. Harrington, SPT, Natasha R. Kopecky, SPT, Bradley D. Matthews, SPT, Lauren M. Ott, SPT, Remy R. Coeytaux, M.D., Ph.D.

Introduction
- Shoulder pain is highly prevalent in manual wheelchair users with spinal cord injury (SCI)
- Incidence and severity of shoulder pain in this population has been shown to increase with time post-injury due to abnormal loading forces
- Therapeutic exercise has been demonstrated to be an effective, conservative approach to treating shoulder pain in able-bodied individuals
- The purpose of this review is to evaluate current literature on the effectiveness of exercise programs on the reduction of shoulder pain in manual wheelchair users with SCI

Methods
- Searched the English language literature through PubMed, CINAHL, Web of Science, and EMBASE
- Key words: spinal cord injury, manual wheelchair users, shoulder pain
- Eligibility criteria: prospective study design, adult patient with SCI who uses a manual wheelchair; an exercise intervention for shoulder pain, and use of the Wheelchair Users’ Shoulder Pain Index (WUSPI) outcome measure
- Followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1)
- Utilized the checklist proposed by Downs and Black to assess study quality

Figure 1

Records identified through database searching (n=424)
Additional records identified through other sources (n=8)
Records after duplicates removed (n=228)
Records screened (n=228)
Full text articles assessed for eligibility (n=16)
Full text articles excluded due to not meeting all inclusion criteria (n=10)
Studies included in qualitative synthesis (n=6)

Table
<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Study Design</th>
<th>N</th>
<th>Interventions</th>
<th>Study Period</th>
<th>WUSPI Change Score (P-value between groups)</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtis, 1999</td>
<td>RCT</td>
<td>42</td>
<td>HEP vs. no intervention</td>
<td>6 months</td>
<td>HEP: +3.1, No intervention: -0.4 (p=0.379)</td>
<td>Good</td>
</tr>
<tr>
<td>Midsough, 2013</td>
<td>RCT</td>
<td>15</td>
<td>HEP vs. HEP + EMG biofeedback</td>
<td>8 weeks</td>
<td>HEP: +1.9, HEP + EMG biofeedback: -7.0 (NA)</td>
<td>Fair</td>
</tr>
<tr>
<td>Murray, 2011</td>
<td>RCT</td>
<td>71</td>
<td>HEP vs. attention control</td>
<td>12 weeks</td>
<td>HEP: -36.3, Attention control: +0.2 (p=0.001)</td>
<td>Good</td>
</tr>
<tr>
<td>Nash, 2007</td>
<td>Cohort</td>
<td>7</td>
<td>CRT</td>
<td>4 months</td>
<td>CRT: -26.8</td>
<td>Fair</td>
</tr>
<tr>
<td>Nowoczenski, 2006</td>
<td>Cohort</td>
<td>41</td>
<td>HEP vs. asymptomatic control</td>
<td>3 weeks</td>
<td>HEP: -22.25, Asymptomatic control: +2.01 (p=0.002)</td>
<td>Fair</td>
</tr>
<tr>
<td>Norbrink, 2012</td>
<td>Cohort</td>
<td>3</td>
<td>Double-poled ergometry</td>
<td>10 weeks</td>
<td>Exercise: -19 (NA)</td>
<td>Fair</td>
</tr>
</tbody>
</table>

Figure 2

Pictured: scapular retraction (left), pectoralis major stretch (middle), and shoulder external rotation (right)

Stretching exercises:
- Anterior capsule/pectoralis major
- Biceps brachii
- Upper trapezius
- Posterior capsule
- Cervical rotation

Strengthening exercises (with or without EMG biofeedback):
- Shoulder external rotation
- Scapular retraction
- Shoulder adduction
- Shoulder extension
- Scaption
- Middle and lower trapezius pinches
- Serratus anterior pinches

Arm Ergometry:
- Independent of other interventions
- In circuit format with resistive strengthening (military press, horizontal rows, preacher curls, latissimus pull-down, and seated dips)

Results
- 6 primary studies met our eligibility criteria
- The table summarizes the duration of intervention, change score for each intervention group, whether a statistical significance was found, and quality of each study
- Duration of study intervention ranged from 8 weeks to 6 months
- Reduction in WUSPI score exceeded the minimal detectable change (MDC) of 5.10 (Curts 1995) displaying a clinically important change in shoulder pain in all intervention groups
- No adverse events were reported in any of the studies that were directly attributable to the exercise intervention

Clinical Relevance
- Stretching, strengthening, EMG biofeedback, and arm ergometry are applicable interventions that can be utilized independently or in combination
- Figure 2 lists all interventions used throughout the 6 studies; the pictures depict 3 commonly utilized exercises
- Based on the most common exercises performed that improved the WUSPI and pain in this population a semi-standardized shoulder program could be created, composed of anterior shoulder joint stretches, posterior musculature strengthening exercises using EMG biofeedback training, and an overall endurance component
- A program should be individualized to the patient’s needs to prevent exacerbation of their symptoms and progress as appropriate
- Current literature supports exercise as a feasible, conservative, and therapeutic intervention for the treatment of shoulder pain in our population of interest

Recommendations
- Additional high quality studies are needed to further evaluate and differentiate techniques for the reduction of shoulder pain
- Further studies should also focus on determining the most efficient and effective time frame of intervention with the potential to develop a semi-standardized program that can be individualized to each patient’s needs

References