Resistance Training for Strength in Cerebral Palsy

Sarah Westwater-Wood

If as humans we are designed to move then muscle form and structure is the mechanism by which we move.

Westwater-Wood 2013

For adults there is a strength threshold for functional movement and a threshold above which strength is task specific

Shepherd 2014 p34
Learning Outcomes

• Revise/update current resistance training guidelines for typically developing children
• Revise/apply current resistance training guidelines for children with CP
  – Explore effectiveness of resistance training in children with CP
Definitions

- **Muscle strength** - the amount of force a single muscle or group of muscles can produce in one maximal contraction

- **Resistance training** – improves all components of muscular fitness including strength, endurance and power

- **Adolescence** – not differentiated by chronological age but rather maturation rates (girls 12-18 boys 14-18 years)

- **Childhood** – girls and boys up to age of 11 and 13 years yet to develop secondary gender characteristics
RT for children/adolescents

Alone or as part of a multifactorial program RT shows significant improvements in

Results of Cessation of exercise programs which include RT

- Body composition improvements regress
- Cardiovascular risk factors increase
- Quickest detraining occurs with short duration program

Injuries – association with poor supervision (Lloyd, Faigenbaum, Stone et al 2013)
RT impact on Strength child vs adolescent

Children
Mainly neuroplasticity & CNS maturation
• Motor unit recruit
• Firing frequency
• Synchronisation
• Myelination

Adolescents
Mainly structural
• Hypertrophy/Cross-sectional area
• Hormonal drive
• Muscle architecture
• Neural voluntary activation level
• Motor unit differentiation
• Some fixing of CNS & neuroplasticity

Training age

Lloyd, Faigenbaum, Stone et al 2013
And (work of Gough and Shortland 2011-2012)
What about risks?

<table>
<thead>
<tr>
<th>Current Evidence Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skeletal development</td>
</tr>
<tr>
<td>Growth plates</td>
</tr>
<tr>
<td>Injury/injury risk</td>
</tr>
</tbody>
</table>

Lloyd, Faigenbaum, Stone et al 2013
Now think CP?

A neurological condition therefore possible;
- Reduction in neurological adaptability
- Reduced voluntary muscle activation
- Often chronic neural and muscle tissue negative adaptations
- Improvements in strength not proportionate to functional changes

Alternatively
- SR of RCT; RT in CP lower limbs research findings are equivocal
  - Verschuren et al 2011
- RT shown to improve gastroc muscle volume and the oxidative metabolic capacity
  - Gough and Shortland 2013
- RT has been effective in stimulating hypertrophy
  - McNee et al 2009

Have we yet to find the most effective RT protocol?
Learning from our Elders

Learning from our elders

Solid line typically developing individuals

Dash-dot line those with CP

Shortland 2009 DM&CN commentary
Elements of Prescribing RT Exercise

• The individual *child/adolescent with CP*
• Overload – *core of prescribing an effective dose of exercise.*
• FITT principles
• 1 RM

McArdle, WD; Katch, FJ; et al (2011)
### FITT principles; a RT protocol

<table>
<thead>
<tr>
<th>Overload factor[s]</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Episodes per week</td>
<td>3 times a week</td>
</tr>
<tr>
<td>Intensity</td>
<td>Load/amount of weight</td>
<td>1 rep of maximum is the threshold</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Perceived exertion</em></td>
</tr>
<tr>
<td>Time(Duration)</td>
<td>Time spent or repetitions And length</td>
<td>3 sets of 12 reps</td>
</tr>
<tr>
<td></td>
<td>of program overall</td>
<td>Number of weeks</td>
</tr>
<tr>
<td>Type(mode)</td>
<td>Type of exercise</td>
<td>In this case PRE but could be endurance</td>
</tr>
<tr>
<td>Rest</td>
<td>Recovery time</td>
<td>Both per lift and per episode</td>
</tr>
<tr>
<td>Mode</td>
<td>type of training undertaken</td>
<td>RT, Cardiovascular</td>
</tr>
</tbody>
</table>

Key: PRE, progressive resistance exercise, rep[s], repetition[s]
Brooks et al., 2004, Katch et al., 2011
ACSM’s guidelines 8th Edition 2009 pg 165
## RT FITT for child & adolescent with CP

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<th>Overload factor[s]</th>
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<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>3 per week non consecutive Or non consecutive days</td>
<td>Verschuren et al 2011; Lloyd et al 2013</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>Intensity -Volume</td>
<td>Novice 60% 1RM x 1-2 sets of 1-3 reps Progress up to 80% 1RM x 2-4 sets of 6-12 reps</td>
<td>Lloyd et al 2013</td>
</tr>
<tr>
<td>Time (Duration)</td>
<td>Short term 8-20 weeks Likely that required throughout life</td>
<td>Verschuren et al 2011; Lloyd et al 2013</td>
</tr>
<tr>
<td>Type (mode)</td>
<td>Resistance or progressive resistance with a variety of exercises (6-8) beginning with isolation of single muscle groups or joints</td>
<td>Verschuren et al 2011; Stabenow and McCambridge 2008</td>
</tr>
<tr>
<td>Rest</td>
<td>Recovery time between sets 1-3 mins Between episodes at least</td>
<td>Verschuren et al 2011; Lloyd et al 2013</td>
</tr>
<tr>
<td>Warm Up</td>
<td>5-10 mins dynamic movement including rehearsing activities to come</td>
<td>Stabenow and McCambridge 2008 Verschuren et al 2011</td>
</tr>
</tbody>
</table>
Estimating 1 RM in children with CP

With experience and reference to established protocols it is suggested that estimating 1RM can be simply achieved in children (Skinner 2005, Saltarelli 2009). For those with CP 1RM may be inappropriate therefore 80% 1RM is a reasonable approach. Westwater-Wood MPhil Thesis 2013 the following is a protocol for estimating 80%1RM in children with CP.

<table>
<thead>
<tr>
<th>STEP</th>
<th>ACTIVITY</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The child should undertake warm up exercises including unloaded ST exercise movements and other dynamic activities. Duration 5-10 mins</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A weight is selected which is estimated to be within the child’s 50-70% capacity. 6 repetitions are performed smoothly through full range of available movement</td>
<td>Quality of movement and signs of fatigue are monitored</td>
</tr>
<tr>
<td>3</td>
<td>Where there are no indications of poor form, movement or fatigue a 2 min rest period follows then go to step 5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Where signs of fatigue or poor movement are noted weight is reduced by the minimum unit (0.5kg) and 6 repetitions performed.</td>
<td>This would be the set load for performing the RT</td>
</tr>
<tr>
<td>5</td>
<td>Add the next unit of weight (0.5kg) and perform 6 repetitions.</td>
<td>Quality of movement and signs of fatigue are monitored</td>
</tr>
<tr>
<td>6</td>
<td>If completed without sign of fatigue or poor movement 2 mins rest followed by step 5 again</td>
<td>If there are signs of fatigue or poor movement go to step 4</td>
</tr>
</tbody>
</table>

References

• Bass, SL., (2000), The perpubertal years – a unique opportune stage of growth when the skeleton is most responsive to exercise, Sports Medicine, 30:73-78
• McArdle, WD; Katch, FJ; Katch, VL (2002) Exercise Physiology energy, nutrition and human performance, Lippincott Williams and Wilkins
• Naylor, LH., Watts, K., Sharpe, JA, Jones, TW., Davis, EA, Thompson, a., George, K., Ramsay, J., O’Driscoll, G., Green, DJ. (2008) Resistance training and diastolic myocardial tissue velocities in obese children, Medical Science and Sports Exercise, 40-2027-2032
References

- Shepherd R (2014) Cerebral Palsy in Infancy, Churchill Livingstone
- Westwater-Wood S (2013) MPhil Thesis, University of Nottingham and British Library
- Westwater-Wood S (2014), Hip Strength Training in Children with Cerebral Palsy: Development of a Methodology and Feasibility of a Single Blinded RCT, MPhil, University of Nottingham

Websites

- Cerebral Palsy Alliance guidelines “the minimum requirement is two sessions of muscle strengthening activities per week”
- ACSM Youth Strength Training; Facts and Fallacies
  http://www.acsm.org/public-information/articles/2012/01/13/youth-strength-training-facts-and-fallacies
- WHO Global recommendations on physical activity for health, 5-17 years “including those that strengthen muscle and bone*, at least 3 times per week.”
  http://www.who.int/dietphysicalactivity/factsheet_young_people/en/