Exercise physiology and exercise tests in children and adolescents with cerebral palsy

Program
- Testing children with CP
- Theory exercise physiology
- Exercise tests (field tests)
- Practical session (after break)

Aerobic Capacity

Aerobic Capacity

Stroke Volume

Heartfrequency

CaO₂ = CvO₂

Aerobic Capacity


Van Leeuwen et al 2004 Geneeskunde & Sport

Muscle biopsy

Eriksson & Saltin Acta Paed Belgica 1972

Takken & Hulzebos 2007 Sport & Geneeskunde

XX: 220-age = FALSE

ATP, CP and Glycogen concentrations in the muscle

Anaerobic Capacity

Anaerobic Capacity and Development
Recovery in HR after repeated anaerobic exercise

Conclusion Aerobic and Anaerobic Capacity
- Big increase in anaerobic capacity in children (> aerobic capacity)
- Children recover faster after (repeated) exercise

Muscle Strength and Development

Muscle Strength and Development

Conclusion Muscle Strength
- Increase with age/body weight/ body height
- Difference between boys and girls at 12 years of age
- Girls are plateauing earlier than boys

Methods: Muscle Strength (Hand-Held Dynamometer)

Methods: Muscle Strength (Hand-Held Dynamometer)

Fitnesstests in children with Cerebral Palsy

Evaluation

Fieldtests in children with CP
- Nonthreatening, inexpensive, easy to administer in a nonresearch setting
- Reliable and valid
- To evaluate a training(period)
- Specific (= functional !!)

Every test result is specific for the movement pattern that was used:
Child able to walk à→ test must be related to walking
Child who uses a wheelchair à→ test must be wheelchair-related
Research group
- Children diagnosed with spastic CP
- GMFCS I to IV
- Age: 7 -18 years
- 8 Pediatric Physical Therapists
- 2 Exercise Physiologists

Often used aerobic tests
Skill: Walking
- 20-meter shuttle run test (beep test)
  - Problematic due to the high starting speed and increasing speed.
- Treadmill (Bruce and Balke protocol)
  - Many protocols are not suitable due to the high starting speed, inclining floor and/or increasing speed.

New CP-Treadmill test
- GMFCS level 1
  - Slope 2%
  - Starting speed 5 km/hr
  - per minute +0,25 km/hr
- GMFCS level 2
  - Slope 2%
  - Starting speed 2 km/hr
  - per minute +0,25 km/hr

10-m Shuttle Run Test
- Beep test. Sound (beeps) on CD
- 10 meter (Gym)
- Increasing speed
- VO₂-max related to achieved level

Research
- Treadmill
  - 1x VO₂peak and HRpeak measurement
- 10-m Shuttle Run Test
  - 1x VO₂peak and HRpeak measurement
  - 1x HRpeak measurement
Video example
10 meter Shuttle Run Test
- M. (boy)
- 15 years of age
- GMFCS level II

Validity
10 m Shuttle Run Test vs Treadmill:
VO2 (l/min)

Achieved level (= time in minutes)

Shuttle Run Test 1
Shuttle Run Test 2

Reliability

Reference values GMFCS level I

Reference values GMFCS level II

Conclusion
- 7.5 and 10-m shuttle run tests:
  - Are valid
  - Are reliable
  - Can be used for children with CP (classified at
    GMFCS level I, II and III) and have
    advantages over a treadmill.

Useful anaerobic tests
- Walking
  - 10x5 meter sprint test
  - MPST (Muscle Power Sprint Test)

Anaerobic test
- 10x5 meter sprint test
  - > 5 meter
  - Stopwatch
  - Register time on a score form
Video example 10x5 meter sprint test

- M (girl)
- 14 years of age
- GMFCS level II

**Reliability**

Observer 1 (time in secs) vs Observer 2 (time in secs)

Reliability
ICC = 1.00

**Reference values GMFCS level I**

**Reference values GMFCS level II**

**MPST**
Muscle Power Sprint Test
- 6 15 meter sprints at a maximum pace
- 10-second rest between sprints

**MPST**
- Power output can be calculated based on times, body mass and distance (15 meter):
  - Peak en mean power

15 meter
Video example
Muscle Power Sprint Test
• T. (boy)
• 15 years of age
• GMFCS level I

Reliability
Muscle Power Sprint Test (Mean Power)
Rate 1 (Watts)
Rate 2 (Watts)
ICC=0.98

Validity of the MPST
Reference values GMFCS level I
Typically developing boys
Typically developing girls

Reference values GMFCS level II
Typically developing boys
Typically developing girls

FITTNESS

WHEELCHAIR

• 10-m shuttle test
  • 10 meter (gym)
  • Increasing speed

Aerobic capacity

Anaerobic capacity

Aerobic capacity tests
• Maxtest (aerobic capacity)
  • LABTEST: Armergometer (McMaster all-out protocol)
  • FIELDTEST: 10 meter Shuttle Ride Test

Aerobic capacity research
• Armcranking
  – 1x VO_{2peak} and HR_{max} measurement
• 10-m Shuttle Ride Test
  – 1x VO_{2peak} and HR_{max} measurement
  – 1x HR_{max} measurement

Aerobic capacity validity and reliability
Test 1
Test 2
Pearson
VO_{2peak} Shuttle test
0.84*

Anaerobic capacity

Muscle Power Sprint Test
• 3 times a sprint of 15 meter
  • rest between sprint is 10 seconds
Peak mean power can be calculated

Field Tests

Lab-test: WAnT armcranking
• Protocol
  – 2 minute warm up
  – 5 second countdown
  – Rolling start
  – 30 seconds all out
  – Breaking force 0.26 kg/m
  – 2 minute cool down
Validity

<table>
<thead>
<tr>
<th>Muscle Power Sprint Test</th>
<th>Mean 30 sec</th>
<th>Power 30 sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingate MPST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Power</td>
<td>1200</td>
<td>900</td>
</tr>
<tr>
<td>Max Power</td>
<td>1500</td>
<td>1200</td>
</tr>
<tr>
<td>Test power sprint test</td>
<td>600</td>
<td>500</td>
</tr>
</tbody>
</table>

But…

- Are these tests really anaerobic?

<table>
<thead>
<tr>
<th>Duration</th>
<th>Outcome</th>
<th>Power</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 sec</td>
<td>Power</td>
<td>27.29 ± 6.6 sec</td>
<td>Power</td>
</tr>
<tr>
<td>30 sec</td>
<td>Power</td>
<td>31.2 ± 8.3 sec</td>
<td>Time</td>
</tr>
</tbody>
</table>

3.5 x 5 meter (10.5 sec)

Conclusion anaerobic tests

- 10x5 meter sprint test
  - Measures the ability to change the direction of the body abruptly (agility)
- MPST (anaerobic sprint test)
  - Measures the ability to exert strength quickly = anaerobic capacity (power)

Anaerobic test

Conclusion anaerobic tests

- Both sprint tests:
  - Are reliable
  - Measure different aspects of anaerobic capacity
  - Can be used for children with CP (classified at GMFCS level I to IV)

But……

- There is more than aerobic and anaerobic capacity

Anaerobic test

Conclusion

ShuDle Run/Ride Test

Anaerobic capacity

Conclusion

Anaerobic capacity

Anaerobic capacity

But……

- There is more than aerobic and anaerobic capacity
Submaximal test

- The role of testing may be limited in children and adolescents, since maximal performance may be limited by spasticity, muscle strength, or skills rather than exertion.
- Submaximal exercise tests have been suggested as an alternative for maximal exercise testing.

6 Minute walk test

- Reliable in children with CP.
  - ICC= 0.98 (Thompson et al. 2008)
  - ICC= 0.98 (Maher et al. 2008)

6 minute push test

- Variation on 6 minute walk test.

Instructions

- At minute one: “Five minutes remaining. Do your best!”
- At minute two: “Four minutes remaining. You’re doing well - keep it up!”
- At minute three: “Half way point. Three minutes remaining. Do your best!”
- At minute four: “Two minutes remaining. You’re doing well - keep it up!”
- At minute five: “One minute remaining. Do your best!”

Reliability

But....

- 5 children reached a HR<sub>6MPT</sub> ≥ 180 beats/min
- 4 children reached a HR<sub>6MPT</sub> < 100 beats/min

Conclusion

Shuttle Run/Ride Test

Submaximal Test

6 Minute Walk Test

6 Minute Push Test
Let's get active

Take more exercise

Take some fun

Make them sweat

Measure the improvement

Muscle strength tests

- Isometric resistance based methods:
  - MMT
  - HHD

- Isokinetic dynamometry:
  - Computer controlled equipment

- Alternative:
  - Repetition maximum

Muscle strength test

30-sec Repetition Maximum

- Lateral Step-up Test
- Sit-to-Stand
- Attain stand through half kneel

Intertester reliability

- HHD
  - Break-test ICC 0.42 – 0.73
  - Make-test ICC 0.48 – 0.82
- 30-sec RM
  - ICC 0.91-0.96

Conclusion tests

- The reliability of the HHD is questionable.
  - Ways to improve measurement:
    - Use same examiner
    - Use make-method
- The reliability of the 30-sec RM is good.
  - Use standardized protocol
- Can be used for children with CP (classified at GMFCS level I or II)