Validity of Accelerometry to Measure Physical Activity Intensity in Youth with Cerebral Palsy

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Overall Goals

- Establish specific calibration equations for physical activity (PA) intensity for youth with cerebral palsy (CP)
  - Accelerometry & Indirect Calorimetry
- Validate accelerometers to measure PA intensity based on body placement (hip, arm, ankle)
Rationale

- **PA “intensity”**
  - Improved health status
  - Health promotion
  - Clinical interventions

- **CP**
  - Most prevalent physical disability of childhood

- **Accelerometry in Clinical Trials**
  - Systematic, Rigorous, Quantitative
Measuring PA in CP
(Capio, 2010a, Clanchy (in press))

- Direct observation
  - (SOFIT, SOPLAY)
- Self-report
  - (CAPE, ASKp)
- Pedometry - StepWatch
  - Step counts
- Accelerometry - Actigraph, SenseWear
  - Step Counts
  - Activity Counts
  - Intensity, Duration, Frequency
  - Body Placement
StepWatch Activity Monitor
Actigraph Accelerometer
## SenseWear Accelerometer

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
<th>Duration of View</th>
<th>Duration on-body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sat Jul 3, 2010</td>
<td>Tue Jul 6, 2010</td>
<td>3 days</td>
<td>2 days 13 hrs 29 min (85.4%)</td>
</tr>
</tbody>
</table>

### Total Energy Expenditure

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3316 cal</td>
<td>6632</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>2955</td>
<td>3840</td>
<td>3153</td>
</tr>
</tbody>
</table>

### Average METs

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3</td>
<td>1.9</td>
<td>2.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### Number of Steps

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>12326 steps</td>
<td>36277</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps</td>
<td>7766</td>
<td>23525</td>
<td>5095</td>
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</table>

### Active Energy Expenditure (3.0 METs)

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1538 cal</td>
<td>4814</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>1015</td>
<td>2096</td>
<td>1495</td>
</tr>
</tbody>
</table>

### Bed Activity (0.0 - 2.9 METs)

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:50</td>
<td>20:16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
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<th>Sun</th>
<th>Mon</th>
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</thead>
<tbody>
<tr>
<td>Time</td>
<td>15:50</td>
<td>20:16</td>
<td>17:51</td>
</tr>
</tbody>
</table>

### Lying Down (0.0 METs)

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
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<tbody>
<tr>
<td>4:23</td>
<td>8 hrs 46 min</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>7:20</td>
<td>7:35</td>
<td>0:50</td>
</tr>
</tbody>
</table>

### Physical Activity Duration (3.0 METs)

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>4:39</td>
<td>13 hrs 58 min</td>
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<table>
<thead>
<tr>
<th>Day</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
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</thead>
<tbody>
<tr>
<td>Time</td>
<td>3:35</td>
<td>5:18</td>
<td>5:06</td>
</tr>
</tbody>
</table>

### Vigorous Activity (4.0 - 6.9 METs)

<table>
<thead>
<tr>
<th>Daily Avg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:11</td>
<td>32 min</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>0:11</td>
<td>0:07</td>
<td>0:17</td>
</tr>
</tbody>
</table>
Measuring PA Intensity

- Cosmed K4b2
- Provides a breath by breath analysis of oxygen consumption
- ml/kg/min
- Criterion measure of physical activity intensity (METS)
Accelerometry & PA intensity

- **Accelerometry**
  - Validate Activity Counts against O2 consumption to determine PA intensity
    - Use established equations for youth to predict energy expenditure (EE) and PA intensity
    - Recalibrate existing equations to predict PA for youth with CP
Accelerometry & PA intensity (Clanchy, et al, 2009)

- Evaluate capacity of accelerometry to:
  - Differentiate PA intensity in youth with CP
  - Freedson equation:
    - \( METs = 2.757 + (0.0015 \times \text{counts/min}) - (0.08957 \times \text{age [yr]}) - (0.000038 \times \text{counts/minute} \times \text{age [yr]}) \)

- Classification:
  - Sedentary (\( \leq 1.5 \text{METs} \))
  - Light (\( > 1.5 < 4.6 \text{ METs} \))
  - Moderate to vigorous (\( \geq 4.6 \text{ METs} \))
Conclusions (Clanchy et al, 2009)

- Interventions that promote PA in adolescents with CP are vital.
- A valid measure of PA is required to evaluate the efficacy of PA interventions.
- This study demonstrates:
  - The ActiGraph can differentiate among intensities of PA in adolescents with CP.
  - For the purpose of classifying activity intensity, the Evenson cut off points provided the highest classification accuracy for sedentary and moderate to vigorous physical activity in adolescents with cerebral palsy.
Validation Study
Study Protocol

- Design
  - Cross sectional validation study

- Subjects - Youth with CP
  - N=52
  - Aged 8 – 18 years
  - GMFCS Levels I, II, III

- Inclusion:
  - Ambulatory, able to follow directions and comply with protocol, able to comply with exercise testing, able to tolerate wearing equipment

- Exclusion:
  - Musculoskeletal injury, procedures in last six months, unstable medical or emotional status, unable to comply with protocol
Methods

- Study Session
  - Each parent-child dyad participates in one measurement session (2-3 hours)
  - Parent Consent & Child Assent
- Measurement Protocol
- Physical Activity Protocol
  - Increasing demands on PA intensity
Measures

- Parent-Child Questionnaires
- PEDI-CAT – parent reported assessment of child’s functional mobility
- Anthropometrics (height, weight, BMI, skinfold measures)
- Indirect calorimetry (Cosmed K4 b2)
- Accelerometry
  - StepWatch (ankle)
  - Actigraph (hip)
  - SenseWear (arm)
Physical Activity Protocol (PAP)

- Sedentary Activity
  - Quiet resting in supine (7-10 minutes)
- All other PA (5-6 minutes)
  - Quiet sitting
    - hand writing task
- Household Chores:
  - Cleaning table top
  - Folding laundry and carrying laundry bag
- Active Recreation
  - Wii game (running or soccer)
- PA Transportation
  - Three trials of walking
  - Slow, Brisk and Fast Paced Walking
Data Analysis

- Data reduction and analysis using specific software packages for the THREE accelerometers AND the Cosmed Cart
- Time-stamped matching of accelerometry to O2 consumption data
- Use three types of accelerometry data in prediction equations to differentiate PA levels of intensity
Expected Outcome

- Establish that Accelerometry is a valid measures of PA intensity for clinical trials
- Determine best prediction equations to differentiate PA intensity in youth with CP
- Determine which type of accelerometry is best to measure PA intensity in youth with CP
  - Type of PA?
  - GMFCS Level?
- Determine if accelerometry is valid for outcome measures in medical rehabilitation clinical trials
Discussion Points

- Measures
- Measurement Protocols
  - Reduce time burden on participants
- Recruitment Strategies


Damiano DL. Activity, activity, activity: rethinking our physical therapy approach to cerebral palsy. Phys Ther. 2006;86:1534 –1540


References


Physical Activity Guidelines for Americans, November 2008 US Dept Health and Human Services


THANK YOU!

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