Moeheid, fysieke activiteiten en fitheid bij volwassenen met spastische bilaterale cerebrale parese

Wilma M.A. van der Slot, revalidatiearts$^{1,2}$

Channah Nieuwenhuijsen$^2$, Rita van den Berg-Emons$^2$, Marij Roebroeck$^2$

$^1$ Rijndam Rehabilitation Centre, Rotterdam, The Netherlands
$^2$ The Department of Rehabilitation Medicine and Physical Therapy, Erasmus Medical Centre, Rotterdam, The Netherlands
Cerebral Palsy

“CP describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior, by epilepsy, and by secondary musculoskeletal problems.”

(Rosenbaum et al., 2007)
Gross Motor Function Classification System (GMFCS):

- A five-level classification system graded by the age-related severity of gross motor limitations
- Distinctions between levels of motor functioning are based on functional limitations, the need for assistive devices and, to a lesser extent, quality of movement

*(Palisano, 1997)*
Aims today

1. Descriptive:
   - Fatigue
   - Level of physical activity
   - Physical fitness

2. Relationships among physical fitness, level of everyday physical activity, and fatigue
Hypothesis

Symptoms: fatigue

Physical activity

Physical fitness

Participation

Health-related QoL

CVD, diabetes

Comorbidity
Study sample

- Adults with spastic bilateral CP without severe cognitive impairment, aged 25 to 45 years
- Rehabilitation settings (n=10) and the BOSK

Exclusion criteria
- Fully dependent on electrical wheelchair
- Comorbidities interfering with physical activity
- Contra-indications for maximal ergometer test
- Inadequate knowledge of the Dutch language
- Severe cognitive problems and/or legally incapable
Subject characteristics (1)

- Of 208 eligible subjects, 56 participated (response rate 27%)
- Mean age (SD): 36.4 (5.8) years, 62% male

Gross Motor Functioning (GMFCS)

- Level I: 7%
- Level II: 20%
- Level III: 50%
- Level IV: 23%

Limb distribution

- 46% Diplegia
- 54% Quadriplegia
Subject characteristics (2)

**Level of education**
- 30% Prevocational practical education or less
- 27% Prevocational theoretical and upper secondary vocational education
- 43% Secondary non-vocational, higher education and university

**Spasticity in most affected leg**
- 52% 2 muscle groups
- 38% 3 muscle groups
- 10% 4 muscle groups

- Prevocational practical education or less
- Prevocational theoretical and upper secondary vocational education
- Secondary non-vocational, higher education and university

Erasmus MC
Rijndam revalidatiecentrum
Statistical analysis (SPSS)

- Descriptive
  - Independent sample T-tests
  - ANOVA

- Relations
  - Pearson correlation coefficients
  - Spearman correlation coefficients
Fatigue – methods (n=56)

1. Fatigue Severity Scale (FSS)

Severity, frequency and impact on daily life
9 statements; score range 1-7
Mean and fatigue scores

2. Multidimensional Fatigue Inventory (MFI-20)

Assessing the nature of fatigue in the previous two weeks
20-items; 5 scale scores range from 4-20
Mean
Severity of fatigue (FSS)

Fatigue ($\geq 4.0-<5.1$): 20%

Severe fatigue ($\geq 5.1$): 41%

Mean fatigue: higher in CP ($4.4 \pm 1.3$) than the reference sample* ($2.9 \pm 1.1$); $P < 0.001$

No difference for sex ($P = 0.72$) or GMFCS level ($P = 0.08$)

* Merkies, n=113, 54.2 ± 14.8
# Nature of fatigue (MFI-20)

<table>
<thead>
<tr>
<th>Scales / Mean ± SD</th>
<th>CP (n=56)</th>
<th>Reference* (n=67)</th>
<th>Difference (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General fatigue</td>
<td>11.0 ± 4.4</td>
<td>7.0 ± 2.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physical fatigue</td>
<td>10.0 ± 4.0</td>
<td>6.3 ± 2.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mental fatigue</td>
<td>9.3 ± 4.4</td>
<td>7.0 ± 2.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reduction in activities</td>
<td>9.1 ± 3.8</td>
<td>7.0 ± 2.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reduction in motivation</td>
<td>7.7 ± 3.1</td>
<td>6.5 ± 2.2</td>
<td>0.005</td>
</tr>
</tbody>
</table>

* Minderhout, n=67, 41.4 ± 1.26
Nature of fatigue – subgroup analysis

No differences were found for nature of fatigue between men and women or GMFCS level.
Level of everyday physical activity - methods

Accelerometry-based Activity Monitor (AM)
48-h measurement
Level of everyday physical activity - methods

Outcome measures

Duration (% of 24-h period or min/day)

- Dynamic activities: composite measure walking, running, stairs, cycling, wheelchair-driving, general movement

Mean body motility (intensity of dynamic activity; gravitational acceleration [g])

Number of transitions
## Level of everyday PA in CP (n=56)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Adults with CP (n=56) (mean SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of dynamic activities (% of 24-h)</td>
<td>8.1  3.7  = 1 h 57 min</td>
</tr>
<tr>
<td>Mean body motility (g)*</td>
<td>0.020  0.007</td>
</tr>
<tr>
<td>Motility during walking (g)*</td>
<td>0.155  0.037</td>
</tr>
<tr>
<td>Motility during wheelchair propulsion (g)**</td>
<td>0.034  0.011</td>
</tr>
<tr>
<td>Number of transitions (n)</td>
<td>123  45</td>
</tr>
<tr>
<td>Periods of continuous dynamic activities 1-5 minutes (n)</td>
<td>16  11</td>
</tr>
<tr>
<td>Periods of continuous dynamic activities &gt; 5 minutes (n)</td>
<td>1  1</td>
</tr>
</tbody>
</table>

* Mean body motility and motility during walking were assessed for ambulators only (n=49)

** Motility during wheelchair propulsion was assessed for non-ambulators only (n=7)
Duration of dynamic activities in CP (n=56) versus healthy controls (n=45)

**Total:** 8.1% versus 10.9% (p < 0.01)

**Men:** 7.8% versus 9.4% (p = 0.11)

**Women:** 8.4% vs 12.2% (p < 0.01)
Mean body motility in CP (n=49) and healthy controls (n=23)

**Total**: 0.020g versus 0.027g (p < 0.01)

**Men**: 0.019g versus 0.027g (p < 0.01)

**Women**: 0.021g vs 0.028g (p = 0.03)
**Level of everyday PA – GMFCS**

Level of gross motor functioning was significantly related to the level of PA

<table>
<thead>
<tr>
<th></th>
<th>All (n=56)</th>
<th>GMFCS I (n=13)</th>
<th>GMFCS II (n=28)</th>
<th>GMFCS III-IV (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration of dynamic activities (% of 24-h)</strong></td>
<td>8.1 3.7</td>
<td>10.3 2.6</td>
<td>8.3 3.7</td>
<td>5.7 3.1</td>
</tr>
<tr>
<td><strong>Mean body motility (g)</strong>*</td>
<td>0.020 0.007</td>
<td>0.024 0.006</td>
<td>0.020 0.007</td>
<td>0.015 0.005</td>
</tr>
<tr>
<td><strong>Periods of continuous dynamic activities 1-5 minutes (n)</strong></td>
<td>16 11</td>
<td>21 7</td>
<td>17 13</td>
<td>12 9</td>
</tr>
<tr>
<td><strong>Periods of continuous dynamic activities &gt; 5 minutes (n)</strong></td>
<td>1 1</td>
<td>2 2</td>
<td>1 2</td>
<td>1 1</td>
</tr>
</tbody>
</table>

*Mean body motility was assessed for ambulators only (n=49): GMFCS level I (n=13), GMFCS level II (n=24), GMFCS level III-IV (n=12)*
Level of PA in GMFCS I

PA in adults with GMFCS level I seems to be comparable to:

- healthy controls (same age):
  duration of dynamic activities 10.3% in GMFCS level I versus 10.9% in controls ($P = 0.55$)

- adults with unilateral CP (25-35 y): 10.6%
Physical fitness - methods

- Progressive maximal aerobic test on a cycle ergometer (Jaeger ER 800)
- McMaster All-Out progressive continuous protocol
- Gas exchange and HR
  - K4b2; Cosmed
- Polar electro
Physical fitness

- N = 42 ambulatory adults
  (56 minus arm crank ergometry and missing values)

- VO2peak in L/min: mean oxygen uptake during the last 30s of exercise

- VO2peak as % of reference sample (Vos, 2001)

- VO2peak (ml/kg/min)
Physical fitness in CP

- Lower than age-based and gender-based reference values for sedentary Dutch men (3.18 ± 0.25 L/min, $P = 0.03$) and women (2.15 ± 0.30 L/min, $P < 0.01$) [Vos]

- Men had higher levels of physical fitness than women, also after correction for body mass ($P < 0.01$)

- Physical fitness was not related to GMFCS level
## Physical fitness (n=42)

<table>
<thead>
<tr>
<th></th>
<th>Total (n=42)</th>
<th>Men (n=29)</th>
<th>Women (n=13)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak VO2 (L/min)</td>
<td>2.19 ± 0.48</td>
<td>2.40 ± 0.39</td>
<td>1.73 ± 0.32</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>% of reference values [Vos]</td>
<td>77 ± 13%</td>
<td>76 ± 13%</td>
<td>81 ± 12%</td>
<td></td>
</tr>
<tr>
<td>Peak VO2 (ml/kg/min)</td>
<td>31.5 ± 6.3</td>
<td>33.2 ± 6.2</td>
<td>27.9 ± 4.8</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
### Physical fitness (n=42)

<table>
<thead>
<tr>
<th></th>
<th>Total (n=42)</th>
<th>Men (n=29)</th>
<th>Women (n=13)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak power output (W)</td>
<td>144 ± 30</td>
<td>153 ± 26</td>
<td>124 ± 30</td>
<td>0.003</td>
</tr>
<tr>
<td>Peak Heart Rate (bpm)</td>
<td>175 ± 17</td>
<td>172 ± 117</td>
<td>184 ± 13</td>
<td></td>
</tr>
<tr>
<td>% of predicted values (220-age)</td>
<td>96 ± 9%</td>
<td>94 ± 5%</td>
<td>100 ± 7%</td>
<td></td>
</tr>
<tr>
<td>Peak Respiratory Exchange Ratio (RER)</td>
<td>1.19 ± 0.12</td>
<td>1.16 ± 0.11</td>
<td>1.26 ± 0.12</td>
<td></td>
</tr>
<tr>
<td>Perceived exertion (Borg scale)</td>
<td>9.0 ± 1.7</td>
<td>9.2 ± 1.8</td>
<td>8.5 ± 1.3</td>
<td></td>
</tr>
</tbody>
</table>
Relationships among physical fitness, level of everyday physical activity, and fatigue
Relationships - methods

- N = 42

- Fatigue: FSS

- Physical activity: also self-reported level → Physical Activity Scale for individuals with Physical Disabilities: PASIPD
  - 12 items, past 7 days
  - MET h/day
## Descriptives (n=42)

<table>
<thead>
<tr>
<th></th>
<th>Men (n=29)</th>
<th>Women (n=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical fitness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO2peak (L/min)</td>
<td>2.4 0.4</td>
<td>1.7 0.3 *</td>
</tr>
<tr>
<td>% of reference values</td>
<td>76 13%</td>
<td>81 12%</td>
</tr>
<tr>
<td><strong>Level of everyday PA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of 24 h active</td>
<td>8.4 3.4</td>
<td>9.1 3.7</td>
</tr>
<tr>
<td>% of reference values</td>
<td>89 36%</td>
<td>75 31%</td>
</tr>
<tr>
<td>Self-reported (MET hr/day)</td>
<td>14.4 13.3</td>
<td>15.8 11.1</td>
</tr>
<tr>
<td><strong>Fatigue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSS score (mean SD)</td>
<td>4.1 1.2</td>
<td>4.0 1.5</td>
</tr>
<tr>
<td>% fatigue / severe fatigue</td>
<td>21% / 31%</td>
<td>15% / 31%</td>
</tr>
</tbody>
</table>

* P < 0.01
For women: significant relationship between physical fitness and self-reported level of everyday PA ($R_p = 0.61$, $P = 0.03$)
Men with higher levels of physical fitness reported less fatigue

\((R_p = -0.37, \ P = 0.05)\)
No significant relationships for:

Objective level of PA and fatigue:
- Men: $R_p = -0.16, P = 0.42$
- Women: $R_p = 0.29, P = 0.34$

Self-reported level of PA and fatigue:
- Men: $R_p = -0.15, P = 0.44$
- Women: $R_p = -0.13, P = 0.66$
Conclusions

Adults with spastic bilateral CP without severe cognitive impairment, aged 25-45 years, have compared to healthy controls:

- More fatigue complaints
- An inactive life-style, especially those with GMFCS level III/IV
- Low level of physical fitness
Conclusions - relationships

Moderate relationships between:
- physical fitness and self-reported level of PA in women
- physical fitness and fatigue in men

No relation between fatigue and PA (objective or self-reported)
Discussion - previous studies adults CP

- Fatigue: 1 study [Opheim, 2009]: fatigue severity at a comparable level

- PA: self-report studies
  Gaskin, 2008: lower level of PA (age 19-66 y)
  Jahnsen, 2003

- Fitness: in different studies a lower level of fitness
  [Fernandez, 1990; Tobimatsu, 1998]
Discussion - previous studies relationships

- Fatigue and PA: Jahnsen, 2003; Santiago, 2004: no associations

No other studies available

- Physical fitness and PA
- Fatigue and physical fitness
Discussion – Limitations/hypothesis no relationships

- Cross sectional study, small sample, among ambulators

- Imbalance between PA and physical fitness might have a stronger influence on fatigue than PA and fitness itself?

- Other measures (physical strain/energy expenditure) more important

- Other factors more important
Discussion - implications physical training?

- Inconclusive evidence for physical origin of fatigue
- No support for deconditioning

→ physical training?
Discussion - implications low level fitness?


→ Improve fitness
Discussion - implications low level PA?

Improve level of everyday PA according to ACSM guidelines?

CP, including GMFCS I and II: fail to achieve the recommended activity levels →

Based on clinical experience: adapt activities in time and type
Discussion – implications fatigue

Preventative / global treatment

- Minimizing physical load / physical load capacity discrepancy
- Cognitive Behavioral Therapy
- Starting young (young adult teams)
Discussion - treatment fatigue

- Other factors:
  - Medication: anti-spastic
  - Sleep problems: nocturnal hypoventilation
  - Depressive symptoms
  - Pain
  - Other diseases: anemia
  - Diet

- Problem to patient?
Current and future research and actions

Current:
- Interventions aiming to improve PA and fitness (L2M)
- Physical strain/energy expenditure in daily life

Future:
- Longitudinal research on physical training/CBT
- Preventative treatments

Education health care workers
Financial support

This research was supported by grants from:

Child Fund Adriaanstichting

Johanna Child Fund

Foundation Erasmus Pain Fighting Fund

w.vanderslot@erasmusmc.nl