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To cite this article: Annet J. Dallmeijer & Merel-Anne Brehm (2011) Physical strain of comfortable walking in children with mild cerebral palsy, Disability and Rehabilitation, 33:15-16, 1351-1357, DOI: 10.3109/09638288.2010.531374

To link to this article: http://dx.doi.org/10.3109/09638288.2010.531374

Published online: 23 Sep 2011.

Article views: 229

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Physical strain of comfortable walking in children with mild cerebral palsy

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Accepted October 2010

Abstract

Purpose. To evaluate the physical strain of comfortable walking in children with mild cerebral palsy (CP) in comparison to typically developing (TD) children. Physical strain was defined as the oxygen uptake during walking (VO\textsubscript{2walk}) expressed as a percentage of their maximal aerobic capacity (VO\textsubscript{2peak}).

Method. Eighteen children (aged 8–16 years) participated, including eight ambulant children (four girls, four boys) with mild spastic CP (three hemiplegia, five diplegia, GMFCS I: n = 7 and II: n = 1) and 10 TD children. VO\textsubscript{2walk} was measured during 5 min of walking on an indoor track at comfortable walking speed. VO\textsubscript{2peak} was measured in a shuttle run test.

Results. VO\textsubscript{2walk} was significantly higher in CP (19.7 (2.8) ml/kg/min) compared to TD (16.8 (3.6) ml/kg/min, \( p = 0.033 \)), while walking speed did not differ significantly between groups. VO\textsubscript{2peak} was significantly lower in CP (37.2 (2.2) ml/kg/min) compared to TD (45.0 (5.3) ml/kg/min, \( p = 0.001 \)). Consequently, the physical strain during walking was significantly higher in CP (52 (7.7) %) compared to TD (36 (8.4) %, \( p = 0.001 \)).

Conclusions. The higher physical strain during comfortable walking of children with mild CP compared to TD children may be related to reported problems with fatigue in this population, and suggest a need for physical aerobic training programmes.

Keywords: Cerebral palsy, children, oxygen consumption, walking, physical strain

Introduction

Cerebral palsy (CP), defined as a non-progressive injury to the brain, covers a number of neurological conditions, resulting in an abnormal development of movement and postural control. The injury to the brain typically results in impairments in motor function such as muscle weakness (paretic muscles), spasticity and decreased selective motor control, which are the primary causes of limitations in the performance of activities of daily-life and participation [1]. One of the consequences of these motor impairments is increased energy expenditure during walking, compared to healthy children [2–5]. Walking energy expenditure covers both the energy used per unit of time, defined as energy consumption (ECS), and the energy used per unit of distance, referred to as energy cost (EC) and calculated by dividing ECS by walking speed. Especially EC of walking has been shown to be significantly higher (approximately 40%) in children with CP, compared to typically developing (TD) children [6]. This high energetic demand of walking is suggested to affect daily-life functioning [7,8].

Apart from an increased energy expenditure during walking, it has also been shown that children with CP have lower fitness levels than TD children [7,9,10]. Peak oxygen uptake (VO\textsubscript{2peak}), typically used as a measure for aerobic fitness, is lower in children with CP, as has been shown in exercise tests using cycle ergometry [11] or a treadmill [8,12]. Obviously, the combination of these two physiological consequences of CP, an increased energy expenditure during walking and a decreased VO\textsubscript{2peak}, will lead to a high level of relative exercise intensity while walking, leaving only a small metabolic reserve (or VO\textsubscript{2reserve}).
Several therapeutic interventions are aimed at decreasing the energy expenditure during walking in children with CP, for example by prescribing orthoses, by treating spasticity or by surgical procedures [13,14]. However, the role of the subnormal fitness levels in these children has received little attention until now. Only two studies that investigated the energy expenditure during walking also took the aerobic fitness level (measured as $V_{O2peak}$) into account [4,8]. These studies showed that the energy expenditure during walking at a treadmill, expressed as percentage of $V_{O2peak}$, was more than two times higher for children with CP, compared to healthy children, indicating that they impose a much higher metabolic demand on their system. In both studies, subjects were tested on a treadmill, using imposed velocities. This hampers generalisation of the results towards actual daily walking, because a large variability in comfortable walking speeds is typically seen in children with different types of CP [12]. Moreover, it is well known that walking speed (relative to comfortable speed) affects the energy expenditure during walking [3,5]. It is therefore important to test children under realistic conditions (i.e. at their self-selected, comfortable walking speed) that are comparable with daily life conditions. For estimating the maximal aerobic capacity, an adapted shuttle-run test can be applied that has especially been developed for children with CP [15]. The advantage of this aerobic test is that it can also be performed under realistic conditions. In the current study, this test was combined with an ambulant oxygen uptake measurement.

The purpose of this study is to evaluate energy expenditure during walking at a self-selected, comfortable walking speed, in combination with evaluating the maximal aerobic capacity, using an adapted shuttle-run test in children with CP, in comparison to age-matched TD controls. The relative strain of comfortable walking will be determined by expressing the oxygen consumption during submaximal walking as a percentage of the maximal oxygen uptake.

**Methods**

**Subjects**

Eight children with spastic CP were recruited from the Department of Rehabilitation Medicine of the VU University Medical Center (VUMC) in Amsterdam. Inclusion criteria were: (1) spastic diplegia or hemiplegia, (2) Gross Motor Function Classification System (GMFCS) level I or II (being able to walk without walking aids) and (3) 6–16 years of age. Children with CP, who received orthopedic or neuro-surgical treatment in the past 6 months or botulinum toxin treatment in the past 3 months, were not included in the study.

Ten age- and gender-matched typically TD children also participated in this study. Characteristics of the children, including body mass, length and physical activity parameters are listed in Table I. The study was approved by the Medical Ethical Board of the VUMC and all parents and children aged 12 years or older signed an informed consent statement prior to participation.

**Procedure**

All children visited the outpatient clinic of the VUMC Department of Rehabilitation Medicine. Personal characteristics and medical history was recorded. Physical activity was measured with a questionnaire, asking for hours of sport participation per week, hours playing outside per week and hours doing gymnastics per week. Height was measured in...

| Table I. Personal characteristics and physical activity, expressed in hours per week of the participating children. |
|---------------------------------|-----------------|-----------------|-----------------|
|                                | **CP (n = 8)**  | **TD (n = 10)** | **t-test**      | **p-value**     |
| Personal characteristics       |                 |                 |                 |
| Sex (boy/girl)                  | 4/4             | 5/5             |                 |                 |
| Age in years, mean (SD)         | 9.9 (3.0)       | 9.80 (2.9)      | -0.053          | 0.958           |
| Length in cm, mean (SD)         | 143 (16.7)      | 146 (16.6)      | 0.465           | 0.648           |
| Body mass in kg, mean (SD)      | 36.7 (16.9)     | 39.5 (15.0)     | 0.376           | 0.712           |
| GMFCS-level (I/II) n            | 7/1             | Na              | Mann–Whitney U  | Na              |
| Limb distribution (hemiplegia/diplegia n) | 3/5             | Na              |                 |                 |

| Physical activity               | **CP (n = 8)**  | **TD (n = 10)** | **t-test**      | **p-value**     |
| Sports activity (hours/week) median (IQR) | 1.25 (1.00–2.87) | 2.25 (1.87–4.00) | 21.5             | 0.098           |
| Playing outside (hours/week) median (IQR) | 4.00 (1.12–9.25) | 6.50 (2.75–13.75) | 29.0             | 0.326           |
| Gymnastics (hours/week) median (IQR) | 1.25 (1.00–1.50) | 1.5 (1.46–1.56)  | 27.5             | 0.234           |
| Therapy (hours/week) median (IQR) | 0.50 (0.06–1.75) | –               | Na              |                 |

CP, cerebral palsy; GMFCS, Gross Motor Functional Classification System; IQR, inter quartile range; Na, not applicable; SD, Standard deviation; TD, typically developing.
standing position using a wall-fixed measure and weight was determined on an electronic scale. Subsequently, resting energy expenditure was measured during 10 min of sitting, while the children were watching a video. After this, the children performed a 5-min walk test to determine the energy expenditure during walking at comfortable speed. This test was followed by a 1-min walk test, for determining maximal walking speed. After 15 min of rest, a shuttle-run test was performed to determine the maximal aerobic capacity. Tests were performed by two trained medical students and supervised by two experienced researchers.

**Equipment**

Oxygen uptake ($V_O2$), carbondioxide output ($VCO2$) and minute ventilation (VE) were measured continuously during the resting test, the 5-min walk test and the shuttle run test. Here for, a portable gas-analysis system was used; either the $V_{max}ST$ system (Sensormedics, Bilthoven, The Netherlands) or K4b2 system (Cosmed, Rome, Italy). Validation studies showed acceptable validity for both instruments [16,17]. Prior to testing, the flow sensor was calibrated with a 3-l syringe, and the oxygen and carbon dioxide concentration sensors were calibrated with reference gases of a known mixture. Heart rate (HR) was monitored during the test, using a heart rate monitor (Polar Vantage XL, Polar Electro Nederland B.V., Almere), and the data were stored as the average over 5-s intervals.

**Measurements**

**5-Min walk test.** Oxygen consumption of walking ($VO2_{walk}$) was measured during 5 min of walking on a level circular indoor track of approximately 50 m. Children were asked to walk at their self-selected, comfortable walking speed. To achieve this, instructions were given to walk in the same way as they were used to in daily life. The children were allowed to wear their typical orthoses and orthopaedic shoes or inlays. $VO2$, $VCO2$, VE and HR were measured continuously during the whole test. Reliability of the protocol has been established in a former study [6], reporting satisfactory intra class correlation coefficients (ICC) and standard error of measurement (SEM) values for ambulant children with CP.

**1-Min walk test.** To determine maximal walking speed, all children performed a 1-min walk test on the same track as described above. Children were instructed to walk as fast as possible, though running was not allowed. The distance walked in 1 min was calculated to the nearest meter. Concurrent validity of the 1-min walk test has been shown to be good in children with CP [18]. Test-retest reliability was established in a separate pilot study in 14 ambulant children with CP (GMFCS I and II), showing an excellent ICC (0.97) and SEM (4.1 m) (unpublished results from our own institute).

**Maximal aerobic exercise test.** All children performed a shuttle run test to determine their maximal aerobic capacity. For the children with CP, we used the specially adapted shuttle-run test protocol for ambulatory children with CP [15]. Walking speed was imposed by two auditory signals, indicating the time to complete a 10-m track. Speed was increased by decreasing the time interval between the auditory signals. Children with CP started at 5 and 2 km/h for GMFCS I and II, respectively. The TD children performed the regular 20-m shuttle run test for children [19]. In this test, the initial speed was set at 8 km/h and it was increased with 0.5 km/h each minute. When the children were not able to maintain the imposed speed (i.e. if they were not within 1.5 m of the end of the track before the next signal), they were still encouraged to continue in order to reach their maximal capacity. Validity and reliability of both tests have been proven to be good [15,19,20]. Typical test duration is 5–7 min.

**Data analysis**

Resting oxygen consumption ($VO2_{rest}$ in l/min) and oxygen consumption during walking ($VO2_{walk}$ in l/min) were calculated by averaging the breath-by-breath $VO2$ values over 60 s during steady state, using the successive most stable 20 s values of the last 2 min of the test. Respiratory exchange ratio (RER) was calculated as the ratio between $VCO2$ and $VO2$. HR (b/min) was averaged over the same 60-s time interval. $VO2_{peak}$ (l/min) and peak RER ($RER_{peak}$) were defined as the highest value over 30 s during the shuttle-run test. Peak HR ($HR_{peak}$) was defined as the highest HR recorded over 5 s during the shuttle-run test. Maximal walking speed (m/min) was calculated as the distance (in m) covered in the 1-min walk test. To normalise for body mass, $VO2_{rest}$, $VO2_{walk}$ and $VO2_{peak}$ were divided by body mass and expressed in ml/kg/min. To determine the physical strain of walking, $VO2_{peak}$ was expressed as a percentage of the $VO2_{walk}$ (%$VO2_{peak}$), and HR was expressed as a percentage of the $HR_{peak}$ (%HR).

Comfortable walking speed during the 5-min walk test was calculated and expressed both as absolute speed (in m/min) and as a percentage of the maximal walking speed (% walking speed). To compare the
results of the 5-min walk test with previous studies, walking speed of the 5-min walk test was also used to calculate the EC of walking. To do this \( \text{VO}_{2\text{walk}} \) was first converted to the energetic equivalent in Joules, according to the Garby and Astrup method [21]. Subsequently, this value was normalised according to speed, and expressed in J/kg/m. Furthermore, \( \text{VO}_{2\text{walk}} \) was calculated by subtracting \( \text{VO}_{2\text{rest}} \) from \( \text{VO}_{2\text{peak}} \).

**Statistical analysis**

Independent \( t \)-tests were applied to determine significant differences in subject characteristics and physiological parameters between children with CP and TD children. The non-parametric Mann–Whitney test was used to determine differences between groups for the physical activity parameters.

**Results**

Criteria for maximal effort during the shuttle run test were a peak HR above 190 bpm and a RER equal or above 1.0. All subjects had a peak heart above 190 bpm except for one subject in the TD group who had a peak HR of 189. RER values were above 1.0 in four out of seven participants with CP and in four out of ten TD participants (with one participant in CP and four participants in TD showing values below 0.96).

There were no significant differences between groups for age, gender, length, and body mass (Table I). Two children with CP had an ankle-foot orthosis, and four children had orthopedic shoes or inlays. Physical activity parameters were not significantly different between groups, although sport activity tended to be lower in children with CP (p = 0.098, Table I). Six out of eight children with CP had physiotherapy, ranging from 1 h/month to 2 h/week.

All children were able to perform both the 5-min and 1-min walk test and the shuttle-run test. Due to technical problems, \( \text{VO}_{2} \) measurement failed during the shuttle-run test in one child with CP (8 years, boy, GMFCS II), and HR measurements failed in one child with CP (10 years, boy, GMFCS I) during the 5-min walk test and in another child with CP (12 years, girl, GMFCS I) during the shuttle-run test. So overall, \% \( \text{VO}_{2\text{peak}} \) data were available in 7 CP children and 10 TD children, with \%HR results only being available for 6 CP children.

The results of the 5-min walk test and the 1-min walk test are shown in Table II. Comfortable walking speed was not significantly different between groups, and ranged from 56.3 to 93.0 m/min in the CP group, and from 68.2 to 95.3 m/min in the TD group. The maximal walking speed was significantly lower in the CP group (p = 0.002). Consequently, the relative walking speed of the 5-min walk test was significantly higher for the children with CP (p = 0.001). \( \text{VO}_{2\text{walk}} \) (in ml/kg/min), \( \text{VO}_{2\text{est}} \) and EC were significantly higher in children with CP compared to TD children (p < 0.05, Table II). \( \text{VO}_{2\text{walk}} \) expressed in l/min and \( \text{VO}_{2\text{walk}} \) in ml/kg/min were not different between CP children and TD children, although the latter almost reached level of significance (p = 0.07). Also, the mean HR over a steady-state interval of 60 s showed no significant differences between the groups.

The results of the shuttle-run test are shown in Table III. \( \text{VO}_{2\text{peak}} \) (in ml/kg/min) was significantly lower in the CP group (p = 0.001). No significant differences between the groups were found for \( \text{VO}_{2\text{peak}} \) expressed in l/min, HR\(_{\text{peak}} \) and RER\(_{\text{peak}} \). The physical strain during walking (i.e. \( \text{VO}_{2\text{walk}} \) expressed as a percentage of \( \text{VO}_{2\text{peak}} \)) was significantly higher in children with CP (52%, sd: 7.7%) compared to TD children (36%, sd: 8.4%, p = 0.001). Values ranged from 44 to 63% in children with CP, and from 23 to 48% in TD children. The differences in \( \text{VO}_{2\text{walk}} \), \( \text{VO}_{2\text{peak}} \) and physical strain between groups are shown in Figure 1.

**Table II. Results of the 5-min walk test and the 1-min walk test (mean and standard deviation are shown).**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CP (n = 8)</th>
<th>TD (n = 10)</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfortable walking speed (m/min)</td>
<td>75.7 (11.3)</td>
<td>80.5 (8.5)</td>
<td>-1.027</td>
<td>0.320</td>
</tr>
<tr>
<td>Maximal walking speed (m/min)</td>
<td>110.9 (14.6)</td>
<td>131.8 (10.2)</td>
<td>-3.587</td>
<td>0.002</td>
</tr>
<tr>
<td>% walking speed</td>
<td>68.4 (6.5)</td>
<td>61.1 (4.0)</td>
<td>2.970</td>
<td>0.009</td>
</tr>
<tr>
<td>( \text{VO}_{2\text{rest}} ) (l/min)</td>
<td>0.70 (0.28)</td>
<td>0.61 (0.17)</td>
<td>0.863</td>
<td>0.401</td>
</tr>
<tr>
<td>( \text{VO}_{2\text{peak}} ) (l/min)</td>
<td>19.7 (2.8)</td>
<td>16.1 (3.6)</td>
<td>2.329</td>
<td>0.033</td>
</tr>
<tr>
<td>Net ( \text{VO}_{2\text{walk}} ) (ml/kg/min)</td>
<td>13.7 (2.2)</td>
<td>11.1 (3.3)</td>
<td>1.904</td>
<td>0.075</td>
</tr>
<tr>
<td>( \text{VO}_{2\text{cost}} ) (ml/kg/m)</td>
<td>0.27 (0.08)</td>
<td>0.20 (0.04)</td>
<td>2.478</td>
<td>0.025</td>
</tr>
<tr>
<td>Energy cost (J/kg/m)</td>
<td>5.47 (1.45)</td>
<td>3.96 (0.73)</td>
<td>2.878</td>
<td>0.011</td>
</tr>
<tr>
<td>HR (b/min)</td>
<td>126 (15)*</td>
<td>114 (12)</td>
<td>1.720</td>
<td>0.106</td>
</tr>
<tr>
<td>RER</td>
<td>0.88 (0.07)</td>
<td>0.75 (0.07)</td>
<td>3.719</td>
<td>0.002</td>
</tr>
</tbody>
</table>

CP, cerebral palsy; HR, heart rate; RER, respiratory exchange ratio; TD, typically developing.

*\( n=7 \).
The current study shows that both increased energy expenditure during walking and a decreased maximal aerobic capacity lead to a considerably higher physical strain during comfortable walking for the children with CP compared to TD children. The physical strain, expressed as the oxygen consumption during walking as a percentage of the maximal aerobic capacity was 52% in the CP children compared to 36% in the TD children.

The increased physical strain in children with CP may affect their level of daily physical activity, because it may cause the onset of early fatigue in daily activities like walking, as suggested by Bar Or and Rowland [7] and Maltais et al. [8]. Fatigue is reported as an important factor affecting walking ability in children [22] and adults with CP [23]. Beside this, it has been reported that children with CP are less physically active than their healthy peers [8,24], and that young adults with CP are poorly integrated in sports activities [25]. In addition, a significant negative correlation has been reported between physical activity level and EC of walking in ambulant children with CP [8]. These findings support the idea that a high physical strain of walking is limiting daily-life physical activity in children with CP. The practical implementation of these results is that health professionals should not only focus on treatments to improve the efficiency of walking but should also consider training interventions to improve the maximal aerobic capacity. By applying structured aerobic training programs in order to reduce the physical strain in daily life the occurrence of early fatigue may be reduced or postponed.

Previous and present findings may be interpreted in the light of the ‘activity – physical strain contradiction’. Higher levels of physical strain while walking do not necessarily result in higher fitness levels, but, in contrast, may lead to physical inactivity and a concomitant deterioration in fitness level. It is assumed that, aside from the impaired muscle function, physical inactivity may be responsible for the low VO$_2$peak levels in children with CP. As in able-bodied children, low fitness levels not only increase the risk for health problems on the longer term, but also negatively affect the performance of daily activities. The increased physical strain during comfortable walking in children with CP is expected to affect their activities and participation in daily life. A further deterioration of their aerobic capacity due to physical inactivity is, therefore, suggested to be a serious risk in this population [9,26], and the development of a concomitant debilitative cycle may be prevented by prescribing aerobic exercise. There is limited evidence that (aerobic) fitness can be improved in children with CP [27–29], but further research is required to gain insight into the most optimal training doses for improving the aerobic capacity in this group [27]. It should be further explored whether an improved aerobic capacity in children with CP also reduces early fatigue in activities of daily living.

### Table III. Results of the shuttle run test (mean and standard deviations are shown).

<table>
<thead>
<tr>
<th></th>
<th>CP ($n=7$)</th>
<th>TD ($n=10$)</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO$_2$peak (l/min)</td>
<td>1.39 (0.64)</td>
<td>1.82 (0.81)</td>
<td>-1.161</td>
<td>0.264</td>
</tr>
<tr>
<td>VO$_2$peak (ml/kg/min)</td>
<td>37.2 (2.2)</td>
<td>45.0 (5.3)</td>
<td>-4.144</td>
<td>0.001</td>
</tr>
<tr>
<td>HRpeak (b/min)</td>
<td>197 (8)</td>
<td>200 (7)</td>
<td>-0.913</td>
<td>0.287</td>
</tr>
<tr>
<td>RERpeak</td>
<td>1.02 (0.09)</td>
<td>0.96 (0.07)</td>
<td>1.305</td>
<td>0.212</td>
</tr>
</tbody>
</table>

Results of the 5-min walk test, relative to the maximal capacity

%HR (%) | 63 (16.0)* | 57 (5.1) | 1.043 | 0.315 |

%VO$_2$ (%) | 52 (7.7) | 36 (8.4) | 4.045 | 0.010 |

CP, cerebral palsy; HR, heart rate; RER, respiratory exchange ratio; TD, typically developing; %HR, HR during comfortable walking expressed as percentage of the HRpeak; %VO$_2$, oxygen consumption of comfortable walking expressed as a percentage of VO$_2$ peak.

* $n=6$. 

### Figure 1. Oxygen consumption of walking (VO$_2$walk), peak oxygen uptake (VO$_2$peak), and VO$_2$walk expressed as a percentage of VO$_2$peak (%VO$_2$) for children with cerebral palsy (CP) and typically developing (TD) children. *Significantly different from TD ($p < 0.05$).
54% (at 3 km/h) (versus 23% in controls) [4,8]. These values are comparable to the results of our study of 52% \(V\text{O}_2\) at comfortable walking speed (68% of fastest walking speed). Average values for \(V\text{O}_2\text{peak}\) (37.2 ml/kg/min) were somewhat higher than earlier reported in more severely affected children with CP who were tested using a treadmill protocol (34.0 ml/kg/min [8] and 32.7 ml/kg/min [12]). One study that validated the shuttle-run test in a large group of ambulant children with CP found a higher absolute \(V\text{O}_2\text{peak}\) (1.7 l/min) than in the present study (1.4 l/min), while no body mass normalised values were reported. The lower values might be explained by differences in age or gender.

All children, except one (HR\text{peak} = 189), reached the criteria for maximal effort based on peak HR (HR\text{peak} \geq 190), while only four children of both the CP and TD group reached a RER \geq 1.0. The latter finding may suggest that a number of children did not reach maximal effort. Peak HR and RER are generally used as secondary criteria for maximal effort, but large individual variations can be present depending on test modes and protocols [30]. It remains to be investigated to what extent the shuttle run test protocol can explain the lower RER values for some individuals in the present study. However, both average peak RER and peak HR values of the present study (1.02 and 197 bpm, respectively) were comparable to average values reported in previous studies in children with CP (ranging from 0.9 to 1.15, and from 189 to 200, respectively) [8,13,16], while almost all subjects in the present study reached the peak HR criterion of 190 bpm. These findings support that the children reached their maximal effort despite lower RER values in some individuals.

Only children with a mild CP participated in this study, reflected in a higher than usually reported walking speed, and somewhat lower EC values, compared to earlier studies in CP [6,8] and comparable to values reported in children with GMFCS level I [3]. Despite the mild severity of CP, we observed an increased EC of walking and a reduced maximal aerobic capacity compared to TD children. It is assumed that children adjust their walking speed to their abilities and maximal capacity. In other words, when the physical strain is too high, children will reduce speed of walking, in order to lower their oxygen consumption levels. In contrast to previous studies investigating the relative exercise intensity of walking [8,12], we investigated the children in a field test and not on a treadmill for both the EC test of walking and the maximal exercise test. An advantage of a field test is that children can walk at their own comfortable speed, incorporating some natural variation in walking speed. Relative comfortable walking speed in our study (68% walking speed) was higher than in TD children (61%), despite the lack of difference in absolute comfortable walking speed.

A limitation of the present study is the small number of subjects. It is necessary to confirm the findings of the present study in a larger population. In addition, it should be explored to what extent a high physical strain is present in more severely affected children with CP. Nevertheless, despite the small sample size, a significant higher physical strain of walking was found in CP compared to TD, illustrating the need to address fitness deficits in future treatment of children with CP.

In conclusion, the high energy expenditure during walking in combination with a reduced aerobic capacity leads to high levels of (relative) physical strain in children with CP. This may lead to inactivity and further deterioration of fitness levels due to fatigue in daily life. Since the aerobic capacity is reduced in children with CP, training to improve the aerobic capacity is indicated as a possible intervention to reduce the relative strain of walking and other daily activities. Further research is required with a larger sample size to confirm the current results. Nevertheless, despite small group sizes, we found remarkable differences between children with mild CP and TD children.

Acknowledgements

The authors thank L.J.M. de Haas and C. van Maris for their help in collecting the data. Children and parents are acknowledged for their willingness to participate in this study.

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