Longitudinal study of motor performance and its relation to motor capacity in children with cerebral palsy

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ABSTRACT

Aim: The aim of this study was to describe the course of motor performance and analyse its relationship with motor capacity over a period of 3 years in 104 children (66 males, 38 females; 43% of those initially invited) with cerebral palsy (CP) aged 9, 11, and 13 years at the start of the study. Forty-one had hemiplegia, 42 diplegia, 21 tetraplegia; 83 spastic CP, 17 dyskinetic/mixed, and four ataxic CP. Gross Motor Function Classification System (GMFCS) levels were I, n = 49; II, n = 15; III, n = 10; IV, n = 12; and V, n = 18.

Method: Motor performance (what a child does do) was determined using the gross motor skills subscale of the Vineland Adaptive Behavior Scales and motor capacity (what a child can do) was determined using the Gross Motor Function Measure-66 (GMFM-66). The measurements were performed annually over a period of 3 years.

Results: The course of motor performance in mildly affected children (GMFCS level I) was more favorable than in more severely affected children. An increase in motor capacity was significantly related to an improvement in motor performance over the 3 years.

Interpretation: Training motor capacity in children with CP seems to be important for improving motor performance. Interventions should also focus on environmental adaptations and improving mobility equipment. A limitation of this study was that the instruments used did not contain the same items on capacity and performance level.

INTRODUCTION

Cerebral palsy (CP) describes ‘a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to nonprogressive 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.' The presence of disturbed movement and posture, causing activity limitations, is a prerequisite in the diagnosis of CP, but the nature and severity of the disturbed motor functioning vary greatly in children with the disorder. Severity of activity limitation in gross motor function in children with CP can range from walking independently, with or without assistive devices, to restriction to an electric wheelchair or dependence on others for transportation. The Gross Motor Function Classification System (GMFCS) is a functional classification system used to classify the severity of motor functioning in terms of motor performance. Motor functioning in children with CP is usually assessed by means of standardized testing procedures with specific instructions that are usually carried out in a controlled environment. These tests measure a child's capacity (i.e. what a child can do), but may not reflect a child's actual performance (i.e. what a child does do) in their own natural environment. In previous research, differences have been found between capacity and the actual performance of
activities in children with physical disabilities, indicating that information about capacity may not necessarily reflect a child’s performance. On the other hand, the relationship between capacity and performance can reflect the success of training.

The prediction of motor functioning in adulthood for children with CP is still a challenging problem. In a recent study of the same cohort that was investigated in the present study, stable motor functioning, measured with the Gross Motor Function Measure (GMFM-66), was found in children and adolescents with CP over a period of 2 years. Motor functioning in that study was defined in terms of capacity (what a child can do). However, whether the development of motor performance (what a child does do) is the same as the development of motor capacity is not clear. This is a highly relevant area for investigation because it provides insight into what children actually do in their natural environment.

Factors that have been found to be related to motor performance in a cross-sectional analysis of children with CP are age, GMFCS level, manual ability, intellectual delay, and seizures. In one study, GMFCS level was found to be the strongest factor associated with motor performance. In adolescents with CP, Palisano et al. found differences in motor performance for various GMFCS levels, but found stable functioning in motor performance for the whole group over a period of 1 year. However, it is not known whether motor performance changes over a longer period of time during adolescence, and little is known about the relationship between motor capacity and motor performance. Tieman et al. reported differences in motor performance across the home, school, and outdoor or community settings in children with CP who had similar capacities. In another cross-sectional study, a weak relationship was found between capacity and performance, but the extent to which changes in motor capacity influence the course of motor performance is still unknown. It is also unknown whether the relationship between motor capacity and performance differs for various GMFCS levels and changes over time. Therefore, the aim of the present study was to describe the course of motor performance over a period of 3 years in children with CP aged 9 to 13 years, and to analyse the longitudinal relationship between motor capacity and motor performance.

METHODS

Participants

Participants in this 3-year longitudinal study (four measurements) were children with CP recruited from rehabilitation centers, special schools for children with mental and physical disabilities, and the outpatient clinics of Departments of Rehabilitation Medicine in the
North-west region of the Netherlands. Of the 244 children identified, 110 children and their parents returned the consent form with a positive response (40 females, 70 males; aged 9, 11, and 13y). Reasons for non-response could be determined in 20 cases, which were the following: language problems (n = 4), moved without a forwarding address (n = 2), participation in other research (n = 2), and family stress (n = 12). Of the 110 children with CP and their parents who were willing to participate, 104 children (66 males, 38 females) had a minimum of two measurements over a period of 3 years, and were included in the analyses. One child did not participate in the second measurement but did participate in the third and fourth. There were two dropouts at the third measurement and eight dropouts at the fourth measurement. As a result, 94 of the 104 children participated in the last measurement (Figure 3.1). Exclusion criteria were the following: insufficient knowledge of the Dutch language and the presence of additional disorders that have an important and lasting influence on movement skills, such as juvenile rheumatoid arthritis or exercise tolerance deficit as a result of severe heart malformation. None of the children who responded had an additional disorder with an important and lasting influence on movement skills. All the regional medical ethics committees approved the study protocol, and written informed consent was obtained from the participating children and their parents. This research was performed as part of the Pediatric Rehabilitation Research in the Netherlands (PERRIN) program (www.perrin.nl), which is a longitudinal study of functioning in children with CP.

**Measurements**

We used the gross motor skills subscale of the Dutch version of the Vineland Adaptive Behavior Scales (VABS) survey form to measure motor performance. The VABS is a reliable and validated instrument, which was designed to assess the performance of children aged 0 to 17 years with and without disabilities, by means of a semi-structured interview with the parents. The VABS subscales include (gross and fine) motor skills, daily living skills, communication, and socialization. Pearson’s correlation between VABS motor skills and the Bruininks-Oseretsky Test of Motor Proficiency score was 0.59 (p < 0.01) and the internal consistency of the VABS was high (Cronbach’s alpha 0.99). The 20 items on the gross motor skills subscale of the VABS assess how the individual performs in gross motor activities, with answers graded 0 to 2 (0 = never performed, 1 = sometimes or partly performed, 2 = usually or habitually performed), thus scores range from 0 to 40. Examples of the items are, ‘jumps over a small object’ and ‘walks stairs with both feet on each step’. To enable comparison between motor performance (VABS gross motor skills) and motor capacity (GMFM-66),
Course of motor performance in CP

Chapter 3

Figure 3.1 Summary of recruitment of study population from the eligible study population and loss to follow-up.

Eligible population \( (n = 244) \)

Invitations delivered \( (n = 242; 100\%) \)

Study population

Consented \( (n = 110; 45.5\%) \)

Participated twice or more \( (n = 104; 43\%, \text{ included in analyses}) \)

2nd measurement \( (n = 103; 42.6\%) \)

3rd measurement \( (n = 99; 40.9\%) \)

4th measurement \( (n = 94; 38.8\%) \)

Participated once \( (n = 6; \text{ excluded from analyses}) \)

Missed 2nd measurement \( (n = 1) \)

Dropped out \( (n = 2) \)

Missed 3rd measurement \( (n = 3) \)

Dropped out \( (n = 8) \)

Invitations returned by post-office \( (n = 2) \)

Declined \( (n = 18; 7.4\%): \)
Language problems \( (n = 4; 1.6\%) \)
Participation in other research \( (n = 2; 0.8\%) \)
Family stress \( (n = 12; 5\%) \)
Did not respond \( (n = 114; 47.1\%) \)
scores of the VABS gross motor skills were recalculated into a percentage of the maximum score, ranging from 0 to 100. A higher overall score indicates better motor performance.

Motor capacity was measured with the GMFM, which is a standardized, reliable, validated observational instrument that was designed to measure change in gross motor capacity over time in children with CP. Test-retest reliability showed that the GMFM-66 has a high level of stability over time (intraclass correlation coefficient [ICC] 0.99) and results of Rasch analyses support the construct validity of the GMFM-66. Items on the GMFM span the spectrum of activities from lying and rolling over to walking, running, and jumping skills. Each GMFM item is scored on a consistent generic 4-point ordinal scale (0 = does not initiate [the task being tested], 1 = initiates [<10% of the task], 2 = partially completes [10–<100% of the task], 3 = completes [the task as outlined in the criterion descriptions]). The GMFM was analysed with the Gross Motor Ability Estimator computer scoring program (GMAE) to obtain the GMFM-66 score. The GMAE rescales the child’s abilities from an ordinal scale to an interval scale, ranging from 0 to 100. A higher overall score indicates better motor capacity.

Severity of CP was classified according to the GMFCS. The GMFCS is a 5-level classification system, in which distinctions between the levels of motor functioning are based on functional limitations, the need for assistive devices and, to a lesser extent, quality of movement. The GMFCS has good reliability and can validly predict motor function in children with CP.

Distribution of CP was sub-divided into three categories, hemiplegia (unilateral involvement), diplegia, and tetraplegia (both bilateral involvement). Tetraplegia was defined as the arms being affected as severely or more severely than the legs; diplegia was defined as the legs being more severely affected than the arms.

Type of motor disorder was subdivided into three categories, spastic, ataxic, and dyskinetic/mixed. Dyskinetic and mixed motor disorders were combined because most children with a mixed disorder had a combination of a dyskinetic and a spastic disorder.

Data collection

All children and their parents attended the Department of Rehabilitation Medicine at the VU University Medical Center in Amsterdam each year. During the visit, one of the two trained researchers asked standardized questions about diagnosis, epilepsy, and type of school, classified the children according to the GMFCS, carried out a physical examination, and administered the GMFM. Interrater reliability was not conducted, but the researchers
were both trained in using the measurement instruments and they performed many of the measurements together. The VABS was scored by a researcher from the Department of Orthopedagogy during a semi-structured interview with the parents or carers of the child. The measurements were repeated after 1, 2, and 3 years.

**Statistical analyses**

Descriptive statistics were used to describe motor performance and motor capacity at each measurement. To determine differences in the course of motor performance over a period of 3 years between GMFCS levels, generalized estimated equations (GEE) were performed using STATA software (version 7.0; Stata Corporation, College Station, TX, USA). The GEE method considers the dependency of repeated measures within one person and allows for a variable number of observations per person. Missing data in the current study were assumed to be ‘missing at random’. For these analyses, VABS gross motor skills (as a percentage of the maximal score) was the dependent variable, and the GMFCS level and the interaction terms of the GMFCS levels with time were the independent variables.

An autoregressive GEE model was used to analyse the relationship between changes in motor capacity and changes in motor performance. In an autoregressive model, the outcome at each measurement is adjusted for the outcome at the previous measurement (i.e. VABS at T2 is adjusted for VABS at T1). For these analyses, VABS gross motor skills (%) was the dependent variable; GMFM-66 minus GMFM-66 at the previous measurement (Δ GMFM-66) and VABS gross motor skills (%) at the previous measurement were the independent variables.

If necessary, the analyses were adjusted for sex, age group, type of motor disorder, and distribution of CP. The threshold for statistical significance was $p < 0.05$.

**RESULTS**

Characteristics of the participants are presented in Table 3.1.

**Course of motor performance**

Mean scores and standard deviations for motor performance (VABS gross motor skills as a percentage) and motor capacity (GMFM-66) at each measurement are presented in Table 3.2. Results of the GEE analyses, showing the relationship between the course of VABS gross motor skills and the GMFCS, are presented in Table 3.3. Significantly different scores for
### Table 3.1 Characteristics of the participating children with cerebral palsy (CP; n = 104)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>66</td>
<td>(63.5)</td>
</tr>
<tr>
<td>Female</td>
<td>38</td>
<td>(36.5)</td>
</tr>
<tr>
<td><strong>Age group, y</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>29</td>
<td>(27.9)</td>
</tr>
<tr>
<td>11</td>
<td>35</td>
<td>(33.7)</td>
</tr>
<tr>
<td>13</td>
<td>40</td>
<td>(38.5)</td>
</tr>
<tr>
<td><strong>GMFCS Level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>49</td>
<td>(47.1)</td>
</tr>
<tr>
<td>II</td>
<td>15</td>
<td>(14.4)</td>
</tr>
<tr>
<td>III</td>
<td>10</td>
<td>(9.6)</td>
</tr>
<tr>
<td>IV</td>
<td>12</td>
<td>(11.5)</td>
</tr>
<tr>
<td>V</td>
<td>18</td>
<td>(17.3)</td>
</tr>
<tr>
<td><strong>Distribution of CP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemiplegia</td>
<td>41</td>
<td>(39.4)</td>
</tr>
<tr>
<td>Diplegia</td>
<td>42</td>
<td>(40.4)</td>
</tr>
<tr>
<td>Tetraplegia</td>
<td>21</td>
<td>(20.2)</td>
</tr>
<tr>
<td><strong>Type of motor disorder</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spastic</td>
<td>83</td>
<td>(79.8)</td>
</tr>
<tr>
<td>Dyskinetic/mixed</td>
<td>17</td>
<td>(16.3)</td>
</tr>
<tr>
<td>Ataxic</td>
<td>4</td>
<td>(3.8)</td>
</tr>
</tbody>
</table>

GMFCS, Gross Motor Function Classification System; n, number; y, year.

### Table 3.2 Gross Motor Function Measure (GMFM-66) and Vineland Adaptive Behavior Scale (VABS) scores for gross motor skills for each Gross Motor Function Classification System (GMFCS) level, (mean, SD)

<table>
<thead>
<tr>
<th></th>
<th>GMFCS I</th>
<th>GMFCS II</th>
<th>GMFCS III</th>
<th>GMFCS IV</th>
<th>GMFCS V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td><strong>GMFM-66</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>90.0 (7.2)</td>
<td>75.5 (6.8)</td>
<td>61.4 (7.2)</td>
<td>40.9 (7.2)</td>
<td>23.3 (9.5)</td>
</tr>
<tr>
<td>T1</td>
<td>90.9 (7.9)</td>
<td>76.9 (7.2)</td>
<td>60.9 (7.6)</td>
<td>40.3 (8.1)</td>
<td>23.4 (8.8)</td>
</tr>
<tr>
<td>T2</td>
<td>91.7 (7.8)</td>
<td>77.2 (9.2)</td>
<td>59.8 (7.4)</td>
<td>39.1 (9.6)</td>
<td>23.3 (8.4)</td>
</tr>
<tr>
<td>T3</td>
<td>92.1 (7.1)</td>
<td>74.8 (8.6)</td>
<td>60.5 (7.8)</td>
<td>40.2 (9.9)</td>
<td>23.7 (7.4)</td>
</tr>
<tr>
<td><strong>VABS gross motor skills (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>85.9 (10.1)</td>
<td>76.0 (12.1)</td>
<td>60.3 (12.3)</td>
<td>35.4 (15.0)</td>
<td>10.8 (4.0)</td>
</tr>
<tr>
<td>T1</td>
<td>87.8 (9.5)</td>
<td>75.0 (11.5)</td>
<td>63.5 (13.1)</td>
<td>34.6 (12.8)</td>
<td>11.8 (4.4)</td>
</tr>
<tr>
<td>T2</td>
<td>91.1 (10.3)</td>
<td>77.1 (12.2)</td>
<td>65.0 (14.4)</td>
<td>27.5 (12.2)</td>
<td>10.8 (6.3)</td>
</tr>
<tr>
<td>T3</td>
<td>92.0 (9.3)</td>
<td>75.5 (13.7)</td>
<td>61.3 (14.8)</td>
<td>30.2 (17.6)</td>
<td>10.7 (6.2)</td>
</tr>
</tbody>
</table>

T, time of assessment.
motor performance were found between all GMFCS levels, except for GMFCS levels I and II (Figure 3.2). The regression coefficients of the interaction terms of the GMFCS with time indicate the change per year in the VABS scores for gross motor skills for each GMFCS level, compared with the reference category (GMFCS level I set at zero, see Table 3.3). A significant, less favorable course of gross motor performance was found for GMFCS levels II, IV, and V, compared with GMFCS level I (-3.85%, -3.72%, and -2.12% each year respectively). In mildly affected children (GMFCS level I), the course of motor performance was more favorable than in more severely affected children. Age group, type of motor disorder, distribution of CP, and sex had no influence on this relationship.

**Table 3.3** Results of generalized estimating equation analyses including Vineland Adaptive Behavior Scales gross motor skills (%) as the dependent variable, and Gross Motor Function Classification System (GMFCS) and the interaction term of this variable with time as the independent variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model with GMFCS and time*GMFCS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
</tr>
<tr>
<td>Constant</td>
<td>82.26</td>
</tr>
<tr>
<td>Time</td>
<td>2.15</td>
</tr>
<tr>
<td>GMFCS level I (ref. cat.)</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>-0.45</td>
</tr>
<tr>
<td>III</td>
<td>-26.17</td>
</tr>
<tr>
<td>IV</td>
<td>-45.95</td>
</tr>
<tr>
<td>V</td>
<td>-68.07</td>
</tr>
<tr>
<td>Time*GMFCS I (ref. cat.)</td>
<td>0</td>
</tr>
<tr>
<td>Time*GMFCS II</td>
<td>-3.85</td>
</tr>
<tr>
<td>Time*GMFCS III</td>
<td>-1.33</td>
</tr>
<tr>
<td>Time*GMFCS IV</td>
<td>-3.72</td>
</tr>
<tr>
<td>Time*GMFCS V</td>
<td>-2.12</td>
</tr>
</tbody>
</table>

Significance set at $p < 0.05$. ref. cat., reference category.

Influence of changes in motor capacity on motor performance

The course of motor performance and motor capacity for each GMFCS level is shown in Figure 3.2.

On an individual level there was a significant relationship between motor performance (VABS gross motor skills) and motor capacity (GMFM-66) over 3 years (Table 3.4). The significant regression coefficient of 0.27 indicated that a change of 1% in motor capacity
The aim of this study was to describe the course of motor performance over a period of 3 years in children with CP, aged 9 to 13 years, and to analyse its relationship with motor capacity. The results showed a less favorable course of motor performance for children at GMFCS levels II, III, IV, and V, compared with children with very mild CP (GMFCS level I) over a period of 3 years. Therefore, the significant regression coefficient of 0.27 per year resulted in a change of 0.27% per year in motor performance. This means that a change of 4% per year in GMFM-66 is needed to achieve a 1% change per year in VABS gross motor skills.

### DISCUSSION

The aim of this study was to describe the course of motor performance over a period of 3 years in children with CP, aged 9 to 13 years, and to analyse its relationship with motor capacity. The results showed a less favorable course of motor performance for children at GMFCS levels II, III, IV, and V, compared with children with very mild CP (GMFCS level I) over a period of 3 years. Therefore, the significant regression coefficient of 0.27 per year resulted in a change of 0.27% per year in motor performance. This means that a change of 4% per year in GMFM-66 is needed to achieve a 1% change per year in VABS gross motor skills.
GMFCS levels II, IV, and V, compared with children with very mild CP (GMFCS level I) over a period of 3 years. Therefore, GMFCS level could be used to identify children who are possibly at risk for deterioration in motor performance during adolescence, and may serve as a guide for interventions. These findings are not consistent with the findings of Palisano et al., who reported no change in the course of motor performance over 1 year for all GMFCS levels. The discrepancy between the findings of Palisano et al. and our study could be explained by the different measurement instruments used in the studies, namely Activities Scale for Kids (ASK) and VABS gross motor skills respectively, and by a difference in the length of the follow-up period. Our findings are partially in agreement with the findings of Day et al., who reported a decline in ambulatory ability in adolescents and young adults who used a wheelchair. It is questionable why, in our study, the course of motor performance children in GMFCS level III did not differ significantly from children in GMFCS level I while children in GMFCS level II did show this difference, and whether the significant differences we found between the other GMFCS levels and GMFCS level I would still be present in a larger study sample. Furthermore, the results could have been influenced by the intellectual abilities of the children which we did not measure in our study. Also, manual ability could have had a small influence on the results, while for some gross motor skills, manual ability was required (i.e. climbing, catching a ball). Therefore, further research is required to study the robustness of these results and the influence of intellectual and manual abilities.

We described the course of motor performance in comparison with the course of motor capacity for different GMFCS levels because it was expected that capacity would exceed performance, but its relationship with the severity of the CP was unknown. Although the measurement instruments could not be compared directly, the results suggest that motor performance of children in GMFCS level III was relatively higher than motor performance of children in other GMFCS levels. This could be explained by the fact that these children used walking aids which increased their motor performance to a higher level than could be expected on the basis of their motor capacity. The results also suggest that in children in GMFCS levels IV and V motor performance was relatively lower than children in other GMFCS levels. Although these findings should be interpreted with care, because different measurement instruments (GMFM-66 vs VABS) were used, these findings suggest that the environment and mobility equipment could probably have an influence on the more severely affected children, and that treatment during growth should, therefore, focus on environmental adaptations, new mobility equipment, and training the children to use this equipment in their own environment. This is consistent with the results of other studies.
in which differences between capacity and performance were found across settings. Tieman et al.\textsuperscript{21} also suggested that interventions might be setting-specific, depending on the person-environment interaction. They suggested that new mobility equipment and training in the use of new equipment might be needed during childhood development.

A positive longitudinal relationship between motor capacity and motor performance has been demonstrated. This is in agreement with the findings of an earlier cross-sectional study in which a weak relationship was found between capacity and performance, and in which it was demonstrated that capacity consistently exceeded performance.\textsuperscript{3} The positive longitudinal relationship we found between motor capacity and motor performance over time might be important because it suggests that a change in motor performance could be achieved through a change in motor capacity. A change of 4\% in the GMFM-66 score is needed to realize a change of 1\% per year in VABS gross motor skills. For the VABS, it is not known what change is expected to be clinically relevant. However, the positive longitudinal relationship between motor capacity and motor performance we found does suggest that training motor capacity is important for increasing motor performance. Although motor growth curves show that children reach 90\% of their motor capacity (measured with the GMFM-66) by around 5 years of age or younger, depending on their GMFCS level,\textsuperscript{22} their motor capacity might be enhanced through the use of aids and mobility equipment. Moreover, individual motor capacity development might vary according to individual characteristics. Several studies have confirmed that motor capacity measured with the GMFM-66 can be enhanced through training,\textsuperscript{23-25} therefore it could be possible that a change in motor performance can be achieved. Furthermore, the course of motor performance in relation to motor capacity in children in GMFCS levels IV and V seems to be less favorable. Therefore during growth, more attention should be paid to interventions that focus on the child’s environment and mobility equipment.

The conclusions that can be drawn from this study only apply to children with a spastic type of motor disorder, because 80\% of the participants had the spastic type of motor disorder. However, this is the estimated proportion in populations with CP. We did investigate whether there was a difference in motor performance over time between children with a dyskinetic motor disorder and children with a spastic motor disorder, but this was not the case. Furthermore, it should be mentioned that the instruments we used to measure motor performance (VABS) and motor capacity (GMFM-66) have different metric properties. The VABS has an ordinal scale and is assessed in an interview with the parents, whereas the GMFM-66 is a test with an interval scale and is performed by the children themselves. The severity of the CP in our study population was very diverse, which made it impossible
to administer a questionnaire to those in the group with cognitive problems. However, we expected parents to be well aware of their child's level of performance. Another limitation of this study was the difference in the items of the VABS and GMFM. To compare performance and capacity on the same items accurately, an instrument such as the Activities Scale for Kids would be more appropriate.¹⁹

**Conclusion**

In conclusion, the course of motor performance over a period of 3 years in children with CP, aged 9 to 13 years, is less favorable for the more severely affected children (GMFCS levels II, IV and V). A positive longitudinal relationship between motor capacity and motor performance has been demonstrated, which suggests that training motor capacity is important for increasing motor performance. Further research, with a longer follow-up period, should be carried out to investigate the course of motor performance in relation to motor capacity over a longer period of time, during which adolescents become young adults. More research is also needed to investigate the role of the environment and the use of mobility equipment on motor performance over time.
REFERENCES


