Manual Ability Classification System for Children With Cerebral Palsy in a School Setting and Its Relationship to Home Self-Care Activities

M. A. Kuijper, G. J. van der Wilden, M. Ketelaar, J. W. Gorter

OBJECTIVE. Our aim in this study was to investigate the relationship between (a) the manual abilities of children with cerebral palsy (CP), assessed with the Manual Ability Classification System (MACS) in a school rehabilitation setting, and (b) the children’s performance of self-care activities at home, assessed with the Pediatric Evaluation of Disability Inventory (PEDI). In addition, we assessed the interobserver reliability of the MACS.

METHOD. Sixty-one children with CP were included (mean age = 10.3 yr, range = 5–14). The MACS was classified by 2 independent raters. The PEDI was scored in a structured interview.

RESULTS. The Spearman correlation coefficient between the MACS and the self-care domain of the PEDI Caregiver Assistance Scale was high and statistically significant (r = .72). The interobserver reliability of the MACS was good (weighted κ = .86).

CONCLUSION. The MACS is a reliable instrument in a school environment and is related to the performance of daily life self-care activities at home.

Cerebral palsy (CP) is a well-defined neurodevelopmental condition beginning in infancy and persisting throughout life. CP encompasses a group of disorders in the development of movement and posture that cause activity limitations and are attributed to nonprogressive disturbances occurring in the developing fetal or infant brain (Rosenbaum, Paneth, Leviton, Goldstein, & Bax, 2007). The need for functional systems to classify the severity of a heterogeneous condition such as CP was recognized in the 1990s. The purpose of a classification system in a clinical setting is twofold: (1) to describe the consequences of CP in a consistent and meaningful way and (2) to enhance the communication between professionals and parents to determine a child’s current needs. Moreover, a classification system with predictive validity can help parents to anticipate their child’s future function (Palisano, Cameron, Rosenbaum, Walter, & Russell, 2006; Rosenbaum et al., 2002). Other possible purposes of functional classification systems include education or research, provided that the instruments can be shown to be reliable and valid for these purposes (Morris & Bartlett, 2004).

Since 1997, two classification systems have been created and validated to classify children with CP on the basis of their functional abilities: the Gross Motor Function Classification System (GMFCS; Palisano et al., 1997, 2006) and the Manual Ability Classification System (MACS; Eliasson et al., 2006). The GMFCS is a five-level classification system of gross motor abilities, that is, the ability to move around. Since the first publication of the GMCS (Palisano et al., 1997), it has been shown to be reliable, valid and, most important,
meaningful with respect to the daily activities and participation of children and adolescents with CP (Donkervoort, Roebroeck, Wieringink, van der Heijden-Maessen, & Stam, 2007; McCormick et al., 2007). The GMFCS is widely accepted among researchers and professionals in the field of childhood disability (Morris & Bartlett, 2004; Rosenbaum, Palisano, Bartlett, Galuppi, & Russell, 2008).

In addition to the GMFCS, a classification of manual ability from a functional perspective, with clear and meaningful levels, was needed. Until recently, the classifications of manual function did not describe daily performance (i.e., what a child does do in daily life). Classification systems focused on manual function, such as the House Classification (House, Gwathmey, & Fidler, 1981), the Modified House Classification (Koman et al., 2008), and the Zancolli classification (Zancolli & Zancolli, 1981), or focused on manual functional capacity (i.e., what a child can do), such as the Bimanual Fine Motor Function (Beckung & Hagberg, 2002). Hence, a need existed for a simple and valid instrument, focusing on performance in daily activities, to get further insight into a child’s daily activities.

On the basis of the concept of the GMFCS, Eliasson et al. (2006) developed the MACS. The MACS is based on the perspective of the child’s typical manual performance in daily life. The instrument focuses on the way children with CP use both of their hands when handling objects in daily activities. These activities should be age appropriate and relevant, such as eating, dressing, and playing, and should not include activities that need advanced skills training, such as playing a musical instrument. Thus, the MACS focuses on everyday performance, is not designed to classify the best capacity, and does not intend to distinguish between hands in terms of capacities. Five levels have been defined in the MACS; the distinctions (just as in the GMFCS) are intended to be clinically meaningful and are based on the way in which a child handles objects and the need for assistance or adaptations to perform manual tasks in everyday life. The five levels and their descriptions are presented in Figure 1. The MACS manual defines distinctions between each pair of levels to assist with determining the level that most closely resembles a child’s manual abilities. The scale is ordinal, and the distances between levels are not considered equal.

The MACS is an easy and quick instrument to classify the manual ability of children with CP. In a clinical setting, it would be useful for professionals to know what a child actually does in daily life. What a child does can be assessed in different ways by various instruments but can be time consuming. Given that occupational therapists and physicians generally see children during the daytime in a school or treatment setting, it is important to ascertain to what extent a child’s MACS level (as classified at school) is related to his or her performance of self-care activities at home. Therefore, our first aim in this study was to examine the relationship between the MACS levels of children with CP as assessed in a school rehabilitation setting and their performance of self-care activities at home.

In everyday practice, occupational therapists and rehabilitation physicians evaluate children from different perspectives. Occupational therapists see a child mostly on a daily basis in the classroom or during a therapeutic session, and they focus on the assessment and treatment of upper-extremity problems in relation to a child’s manual abilities and daily functioning. Rehabilitation physicians see a child in their office during a general assessment, and functional classification is only part of the examination. According to the Dutch guidelines for children with spastic CP (Kwaliteitsinstituut voor de Gezondheidszorg CBO, 2007), all children’s GMFCS and MACS levels should be part of the diagnosis recorded in documents and medical correspondence. It is therefore important to know whether a rehabilitation physician’s MACS classification for a particular child is in agreement with the MACS classification established by an occupational therapist, who has more information on the child’s functioning in the classroom and therapy settings. Our second aim in this study was therefore to assess the interobserver reliability of the MACS between occupational therapists and rehabilitation physicians.

**Figure 1. Manual Ability Classification System levels.**

From Eliasson et al. (2010, p. 2).
Method

Participants

Children with CP attending two schools for special education and rehabilitation were included in the study if they met the following criteria: diagnosis of CP as defined by Rosenbaum et al. (2007) and currently between ages 5 and 14. A child was excluded if his or her parents did not speak Dutch, if the child had a past neurological or orthopedic intervention of the upper extremity, or if the child had been treated with botulinum toxin Type A in the upper extremity in the past 6 months.

Of 72 children with CP at the two schools, 67 met the inclusion and exclusion criteria. All parents were informed about the data collection, and 61 gave consent for their child to participate in the study. We classified the subtypes of CP, distinguished by type of motor disorder (spastic, ataxic, or dyskinetic) and topographical distribution for spastic CP (unilateral or bilateral), according to Surveillance of Cerebral Palsy in Europe guidelines (Gorter et al., 2004; Surveillance of Cerebral Palsy in Europe, 2000).

The severity of functional motor abilities was classified using the Dutch translation of the GMFCS (Gorter, Boonacker, & Ketelaar, 2005; Palisano et al., 1997).

Instruments

The MACS is a systematic method, consisting of five levels, to classify how children with CP use their hands when handling objects in daily activities. Results of a study by Eliasson et al. (2006) demonstrated that the MACS was a reliable instrument (with an intraclass correlation coefficient [ICC] between therapists of .97) and established initial validation. In this study, we used the Dutch translation of the MACS (which can be downloaded at www.MACS.nu). A child’s MACS classification can be assessed by a person who knows the child’s actual performance; using the MACS requires no special training.

Performance in terms of a child’s self-care activities at home was studied using the self-care domain of the Caregiver Assistance Scale of the Pediatric Evaluation of Disability Inventory (PEDI; Haley, Coster, Ludlow, Haltiwanger, & Andrellos, 1992). The PEDI is a judgment-based, standardized instrument using parental reports through a structured interview. The PEDI consists of three scales: Functional Skills, Caregiver Assistance, and Modifications. Each scale consists of three domains: self-care, mobility, and social function. We used the PEDI Caregiver Assistance Scale for self-care activities. Raw scores on the Caregiver Assistance Scale can be transformed into scaled scores, which provide an indication of a child’s performance on relatively easy to relatively difficult items in a particular domain. Scaled scores range from 0 to 100. We used the Dutch version of the PEDI (Wassenberg-Severijnen, Custers, Hox, Vermeer, & Helders, 2003). The interinterview reliability of the Dutch version has been studied and found to be good (ICC = .99 for all scales; Wassenberg-Severijnen et al., 2003), and its validity has been confirmed (Custers et al., 2002).

Procedure

Participating in the study were eight occupational therapists and two rehabilitation physicians, all of whom were familiar with each child. Each child was first classified with the MACS after direct observation in the school setting by an occupational therapist and, independently, by the rehabilitation physician, within 3 wk of each other. The PEDI Caregiver Assistance Scale for self-care activities was then scored in a structured interview with one of the child’s parents. For pragmatic reasons, the interview was done by telephone either by one of the occupational therapists or by one of the rehabilitation physicians. All assessors were trained in the administration and scoring of the PEDI. More than two thirds (69%; n = 42) of the participants were assessed by a therapist, and the other 31% (n = 19) were assessed by one of the two rehabilitation physicians. The MACS classification and the PEDI assessment were performed within a 3-wk period. The rehabilitation physician treating a child retrieved the child’s characteristics from the medical records, including gender, CP distribution, type of CP, age, and GMFCS (Palisano et al., 1997).

Statistical Analysis

We used Spearman rank-order correlation coefficients to analyze the relationship between the MACS, as classified by the therapists, and the scaled score on the self-care domain of the PEDI Caregiver Assistance Scale. Spearman’s rank-order correlations of .1-.29 were categorized as small; those of .3-.49, medium; and those of .5-.1.0, large (Cohen, 1988). Linear weighted κ was used for the interobserver reliability of the MACS levels. We categorized κ statistics as indicating poor agreement when <.20, as fair when .21-.40, as moderate when .41-.60, as good when .61-.80, and as very good when >.8 (Altman, 1997).

Results

Table 1 shows the characteristics of the participating children. Most of the children had CP of the spastic type. Most participants were bilaterally affected, and as a group, they were distributed across all GMFCS levels.
Children were classified by the therapists as follows: 23% as MACS Level 1, 34% as MACS Level 2, 21% as MACS Level 3, 15% as MACS Level 4, and 7% as MACS Level 5.

Figure 2 shows box plots of the relation between the MACS (as classified by the therapists) and the PEDI Caregiver Assistance Scale for self-care activities (scaled score 5 0–100). Medians (25th and 75th percentiles) of scores on the Caregiver Assistance Scale were 81 for Level 1 (range = 74–88), 70 for Level 2 (range = 66–74), 66 for Level 3 (range = 57–75), 42 for Level 4 (range = 26–58), and 8.3 for Level 5 (range = 7–24). Note that a high MACS level represents a lower level of manual ability, implying that these children need more assistance, as reflected by a lower score on the PEDI Caregiver Assistance Scale. Only 5 children of 61 (8%) had a scaled score of 100, indicating they were fully independent in self-care activities. Remarkably, 3 of these children were classified at MACS Level 1, 1 at MACS Level 2, and 1 at MACS Level 3.

The Spearman rank-order correlation coefficient between the MACS levels (as scored by the therapists) and the scores on the PEDI Caregiver Assistance Scale for self-care activities was −.72, which is significant at the .01 level (two-tailed).

Weighted k (with linear weighting) for the interobserver reliability of the MACS between the therapists and physicians was found to be .86 (confidence interval = .78–.94). Fifty children (82%) were classified at the same MACS level by the therapist and the rehabilitation physician (Table 2). Where they disagreed, the difference between the two raters was never more than one MACS level. The therapist classified 7 children more severely than did the rehabilitation physician, and the rehabilitation physician classified 4 children more severely than did the therapist.

### Table 1. Characteristics of the Study Population (N = 61)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n or Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>10.3 (range = 5–14)</td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>36 (59)</td>
</tr>
<tr>
<td>Female</td>
<td>25 (41)</td>
</tr>
<tr>
<td>Type of CP, n (%)</td>
<td></td>
</tr>
<tr>
<td>Ataxic</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Dyskinetic</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Spastic</td>
<td>58 (95)</td>
</tr>
<tr>
<td>Unilateral</td>
<td>22 (37)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>36 (63)</td>
</tr>
<tr>
<td>GMFCS level, n (%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>22 (36)</td>
</tr>
<tr>
<td>2</td>
<td>14 (23)</td>
</tr>
<tr>
<td>3</td>
<td>7 (11)</td>
</tr>
<tr>
<td>4</td>
<td>11 (18)</td>
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<tr>
<td>5</td>
<td>7 (12)</td>
</tr>
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</table>

Note. CP = cerebral palsy; GMFCS = Gross Motor Function Classification System.
A limitation of the current study was that the children were classified only by health professionals. Although Morris, Kurinczuk, Fitzpatrick, and Rosenbaum (2006) demonstrated that, when used by families to assess their child’s manual ability, the MACS’ reliability is high (albeit a little lower than the reliability among professionals), families and professionals observe the child in different environments and thus from different perspectives. The developers of the MACS emphasize that the MACS classification should be based on information from the parents (Eliasson et al., 2006). We realize that MACS classification based on parents’ reports might provide a better indication of self-care activities at home, but our data show that therapists’ MACS classifications provide a useful indication.

Another limitation of the current study is that we do not have detailed information regarding the arguments used by therapists and physicians for their classifications. Hence, we do not know—in cases in which the two disagreed—what the reasons behind the disagreement were. The MACS manual states that the MACS should be used by someone who knows the child well. It might be helpful to define what is meant by “someone who knows the child well.”

Although this study provides some information about the relation between the MACS and daily self-care activities at home, longitudinal studies are needed to learn more about the development of self-care activities at home in relation to the MACS. The GMFCS has proved to be an important predictor of development in terms of gross motor functioning. It is conceivable that the MACS could have the same value for the description of self-care activities.

Our study included a sample of children in the age range of 5–14 yr at a school for special education. The distribution of GMFCS levels across the study population is comparable with that found in the Himmelmann, Hagberg, Beckung, Hagberg, and Uvebrant (2005) study. It is noteworthy that most children were classified at MACS Level 2 (34%); Eliasson et al. (2006) found the same pattern (Level 2 = 40%). Disagreements in our study were distributed across Levels 1–4, but not Level 5, whereas Eliasson et al. found disagreements across all levels. In both studies, differences between observers did not exceed one level.

To our knowledge, no studies on the MACS exist that are comparable to the current study in a school setting. We anticipate that the use of the MACS in everyday practice will enhance the communication between professionals with different backgrounds and between professionals and parents and children, in much the same way that

### Discussion

This study’s results show that the relatively easy classification of the manual abilities of a child with CP by means of the MACS in a school environment is related to the child’s level of performance in terms of self-care activities at home: With a correlation of −.72, 52% of the variance in the PEDI scores can be explained by the MACS classification. Moreover, the degree of assistance with self-care activities in the home situation increases significantly with each MACS level assessed at school, especially for Levels 4 and 5. The MACS levels scored by an occupational therapist in a special school setting can thus provide the team with an estimate of the level of performance of self-care activities at home.

The second aim of this study was to examine whether a rehabilitation physician in clinical practice, who has only a few minutes available, would classify the MACS level in the same way as an occupational therapist in a school setting. The interrater reliability of the MACS levels between occupational therapists and rehabilitation physicians was good (weighted $\kappa = .86$, confidence interval = .78–.94). Where there was less than absolute agreement, the difference between the occupational therapist and the rehabilitation physician was never more than one level.

The current study focused on actual clinical practice. At schools, children are often seen by an occupational therapist in the classroom or in therapy sessions without parents being present. For health professionals, however, it is important to have an idea about a child’s performance at home. Ideally, a full PEDI assessment with the parent would provide the therapist with the most complete information about the child’s needs and functioning, but the full PEDI can be time consuming (Wassenberg-Severijnen et al., 2003) and cannot always be completed in a single session. Therefore, a single MACS classification that correlates with the PEDI score can provide information about areas requiring extra attention in therapy. If necessary, a therapist could always decide to assess a child’s functioning in more detail by means of a full PEDI or a home visit.

### Table 2. Number of Children at Each Level of the Manual Ability Classification System (MACS)

<table>
<thead>
<tr>
<th>MACS Level (Therapist)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>27</td>
<td>7</td>
<td>10</td>
<td>4</td>
<td>61</td>
</tr>
</tbody>
</table>

### References

For a comprehensive list of references, please refer to the original publication.
the GMFCS currently does (Morris & Bartlett, 2004). The MACS can be used in research to describe the characteristics of the study sample, to compare groups, or as a stratification variable in prospective studies. In clinical practice, the MACS might help professionals to describe a child's functional abilities and to guide treatment options.

Summary

The MACS focuses on manual ability in daily life. We found that the MACS, as scored in a school environment by a therapist or rehabilitation physician who knows the child well, is related to everyday self-care activities at home. The MACS is therefore a reliable and useful classification system in a special school setting to provide the team with an estimate of the level of performance in terms of self-care activities at home. If more detailed information on a child’s capability and performance of self-care activities at home is required, the PEDI should be regarded as the measure of first choice, taking into account the amount of time it will take. ▲

Acknowledgments

We acknowledge the children, parents, and therapists of the two schools for special education and rehabilitation in Enschede and Utrecht, The Netherlands, for participating in this study.

References


