

A comparison of functioning, activity, and participation in school-aged children with cerebral palsy using the manual ability classification system

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Abstract. [Purpose] The purpose of this study was to evaluate the functioning, extent of activity, and participation of school-aged children with cerebral palsy (CP) using the Manual Ability Classification System (MACS). [Subjects and Methods] The Subjects were 57 school-aged children (7–12 years old) with CP. The MACS, Gross Motor Function Measure (GMFM), International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) Checklist, and a questionnaire were used to measure children's functioning, activity, and participation. [Results] GMFM scores differed significantly across the MACS levels. The following differed significantly according to MACS level when assessed with the ICF-CY function section: mental functions; sensory function and pain; voice and speech functions; functions of the digestive, metabolic, and endocrine systems; genitourinary and reproductive function; and neuromusculoskeletal and movement related function. The data from the activities and participation section of the ICF-CY also showed statistically significant differences across MACS levels. [Conclusion] These results suggest that the functioning, activity, and participation of school-aged children with CP depend on their MACS level and that the functioning of children with CP affects their activities and participation.

Key words: Cerebral palsy, Manual Ability Classification System, ICF-CY

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INTRODUCTION

Cerebral palsy is a nonprogressive movement disorder that causes physical disability¹⁾. Children with CP experience limitations in their daily activities due to abnormal muscle tone, involuntary movement, unsteady gait, problems with balance, and poor social functioning²⁾. This decreased functioning limits the ability of children with CP to participate in various activities. School-aged children with CP have social and academic difficulties because they have perhaps half the physical strength of normal children, which limits their ability to fully mix with their peer group³⁾.

The Gross Motor Function Measure (GMFM) is commonly used to assess patients with CP. The GMFM is a standardized observational instrument designed and validated to measure changes in gross motor function over time in children with CP⁴⁾.

The World Health Organization (WHO) developed the International Classification of Functioning, Disability and Health (ICF) as a classification of health and health-related

components of well-being, including physical function and structure, activity and participation, environmental factors, and personal factors. All of these components interact with one another⁵⁾. The ICF Child and Youth version (ICF-CY) is an extended version of the ICF that includes child development as an additional health and health-related component.

The Manual Ability Classification System (MACS), which is based on the ICF, is designed to classify children with CP according to the extent of their ability to use their hands and manipulate objects in daily activities. The MACS designates 5 levels of manual function; the lowest level (level I) corresponds to the ability to easily handle objects, and the highest level (level V) indicates severe restrictions in handling objects⁶⁾.

Therefore, the purpose of this study was to assess the functioning, activity, and participation of school-aged children with CP using the ICF-CY, MACS, and GMFM and thereby provide physical therapists, occupational therapists, patients, and families with an understanding of the current functional abilities of these children and basic data for establishing interventions and treatment goals.

SUBJECTS AND METHODS

The subjects of this study were 57 school-aged children (between 7 and 12 years old) who were diagnosed with CP and were receiving physical therapy. The specific selection

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criteria were as follows: no orthopedic surgery within the last 6 months and no botulin or baclofen treatments of the lower limbs during the previous 3 months. Subjects with epilepsy were excluded from this study^{7, 8}. The present study was approved by the Sahmyook University Institutional Review Board (SYUIRB2012-021). The objective of the study and its requirements were explained to the subjects and their parents, and the parents of all subjects provided written consent for their child to participate. The subjects were 40 males (70.2%) and 17 females (29.8%) with a mean age of 114.4 (18.5) months, a mean height of 126.6 (13.4) cm, and a mean weight of 26.1 (7.4) kg. Among the subjects, the type of CP was spastic in 48 (48.2%), hypotonic in 4 (7.0%), and mixed in 5 (8.8%). The limb distribution of CP (N = 48) was quadriplegic in 13 (27.1%), diplegic in 24 (50.0%), and hemiplegic in 11 (22.9%).

The MACS can be used to describe how well children with CP use their hands to handle objects during activities of daily living. The MACS is effective for children between 4 and 18 years of age and classifies children into 5 levels of manual function. Each level is divided into the following categories: ability to handle objects alone in daily living, degree of required assistance, and ability to adapt to perform manual activities. The MACS is used as an assessment of the ability to handle objects, the need for adaptation, and the degree of assistance required to perform movement tasks^{6, 9}.

The GMFM was used to assess gross motor function. The GMFM is divided into 5 domains: A (lying and rolling), B (sitting), C (quadruped and kneeling), D (standing), and E (walking, running, and jumping)¹⁰. It contains 88 items, and scores for each section are summed and divided by 5 to obtain a total score. This measure is used to provide overall standards for the gross motor functioning of subjects by evaluating their abilities rather than specific performance parameters⁴. The GMFM possesses good intra-rater ($r=0.77$, $r=0.88$) and inter-rater ($r=0.68$)¹¹.

The ICF-CY checklist is a summary of the core sections of the ICF-CY and is used to evaluate disability and health conditions in children and youth. The present study reports only the data for body function, activity, and participation from the formative factors of the ICF-CY for the ages of 7–12 years given the age of the subjects and the purpose of the study. Eight areas of bodily function were evaluated: mental function; sensory function and pain; voice and speech function; functions of the cardiovascular, hematological, immunological, and respiratory systems; functions of the digestive, metabolic, and endocrine systems; genitourinary and reproductive functions; neuromusculoskeletal and movement-related functions; and functions of the skin and related structures. The following nine areas were included in the evaluation of activity and participation: learning and application of knowledge; general tasks and demands; communication; mobility; self-care; domestic life; interpersonal interactions and relationships; major life areas; and community, social, and civic life¹². Each section was scored from 0, indicating no difficulty in performance, to 4, indicating a need for full assistance.

All statistical analyses were performed using SPSS,

Table 1. Comparison of GMFM scores in the subjects according to MACS level (N=57)

Categories	Type	n	GMFM score (%)	F(p) Post hoc
MACS level	I	15	92.6 (7.3)	45.896 (0.000) I/III/IV, V
	II	14	81.9 (17.5)	
	III	14	60.9 (21.7)	
	IV	8	27.3 (11.0)	
	V	6	13.8 (9.1)	

MACS: Manual Ability Classification System, GMFM: Gross Motor Function Measure

version 16.0. The general characteristics are presented as frequencies and percentages, with average and standard deviations also provided. A one-way ANOVA was performed to assess the effect of MACS level on GMFM scores and the effects of function, activity, and participation scores from the ICF-CY. A post hoc test using Scheffe's method was employed to compare each group, and the significance threshold was set to $p < 0.05$.

RESULTS

A comparison of GMFM scores in the subjects by MACS level is presented in Table 1. The results indicated significant differences in GMFM scores by MACS level. A comparison of the ICF-CY checklist functions by MACS level is presented in Table 2. The results indicated significant differences by MACS level in mental functions (b1); sensory function and pain (b2); voice and speech functions (b3); functions of the digestive, metabolic and endocrine systems (b5); genitourinary and reproductive functions (b6); and neuromusculoskeletal and movement-related functions (b7). However, functions of the cardiovascular, hematological, immunological, and respiratory systems (b4) and the functions of the skin and related structures (b8) were not significantly different across MACS levels.

A comparison of the activity and participation data from the ICF-CY checklist by MACS level is presented in Table 3. The overall activities and participation section of the ICF-CY checklist was significantly different across MACS levels.

DISCUSSION

The current study assessed the functioning, activity, and participation of school-aged children with CP based on the ICF-CY. This study not only provides basic data that can be used to establish actual treatment goals and interventions but can also enhance our general understanding of rehabilitation for children with CP. This study also used the GMFM and the ICF-CY checklist to compare the functioning, activity, and participation across MACS levels in school-aged children with CP.

The MACS can be used to assess a range of functional restrictions in children with CP. It can be applied to all specific types of CP. The MACS is divided into 5 levels indicating (from lowest to highest) the degree of difficulty

Table 2. Comparison of function list of ICF-CY in the subjects according to MACS level (N=57)

MACS code	Level I (A) (n=15)	Level II (B) (n=14)	Level III (C) (n=14)	Level IV (D) (n=8)	Level V (E) (n=6)	F (p)	Post hoc
b1	3.3 (2.4)	4.8 (2.8)	5.57 (4.9)	11.3 (5.7)	17.5 (3.5)	18.531 (0.000)	A,B,C D E
b2	1.0 (1.7)	1.6 (2.0)	1.9 (2.0)	2.6 (2.3)	6.0 (0.9)	8.202 (0.000)	A,B,C,D E
b3	0.3 (0.7)	0.6 (0.8)	0.9 (1.4)	1.5 (1.6)	3.7 (0.5)	11.763 (0.000)	A,B,C,D E
b4	0.6 (1.4)	0.7 (0.9)	1.1 (2.4)	0.8 (1.4)	1.3 (1.2)	0.330 (0.856)	
b5	0.5 (1.0)	0.8 (1.5)	0.6 (1.3)	0.3 (0.5)	6.2 (2.3)	23.408 (0.000)	A,B,C,D E
b6	0.1 (0.4)	0.2 (0.6)	0.3 (0.6)	0.0 (0.0)	1.7 (1.6)	6.631 (0.000)	A,B,C,D E
b7	9.6 (4.8)	10.2 (5.1)	13.8 (6.9)	20.9 (8.0)	15.5 (6.1)	5.632 (0.001)	A,B D
b8	0.1 (0.4)	0.4 (0.7)	0.4 (0.6)	0.3 (0.5)	0.7 (1.0)	0.986 (0.423)	
Total	15.7 (8.3)	19.4 (8.3)	24.4 (12.0)	37.5 (12.7)	52.5 (11.3)	17.755 (0.000)	A,B D E

Values are means (SD). MACS: Manual Ability Classification System; b1, mental function; b2, sensory functions and pain; b3, voice and speech functions; b4, functions of the cardiovascular, hematological, immunological, and respiratory systems; b5, functions of the digestive, metabolic, and endocrine systems; b6, genitourinary and reproductive functions; b7, neuromusculoskeletal and movement-related functions; b8, functions of the skin, and related structures

Table 3. Comparison of activity and participation list of ICF-CY in the subjects according to MACS level (N=57)

MACS code	Level I (A) (n=15)	Level II (B) (n=14)	Level III (C) (n=14)	Level IV (D) (n=8)	Level V (E) (n=6)	F (p)	Post hoc
d1	2.9 (3.9)	7.9 (5.6)	9.8 (9.9)	18.4 (8.8)	26.2 (2.4)	15.523 (0.000)	A,B E
d2	1.4 (1.8)	2.7 (3.0)	4.3 (4.3)	10.4 (6.1)	15.3 (1.0)	22.401 (0.000)	A,B,C D,E
d3	1.1 (2.6)	4.2 (4.1)	5.4 (6.7)	10.0 (6.4)	18.5 (2.1)	15.964 (0.000)	A D E
d4	4.0 (2.5)	9.4 (5.2)	11.6 (6.2)	21.3 (2.8)	20.0 (4.9)	24.725 (0.000)	A C D,E
d5	2.7 (3.1)	5.8 (4.0)	9.2 (5.5)	16.5 (3.5)	19.5 (0.8)	28.894 (0.000)	A C D,E
d6	0.5 (0.8)	1.2 (1.1)	1.3 (1.4)	2.9 (1.6)	3.7 (0.5)	11.088 (0.000)	A,B E
d7	0.5 (0.7)	0.9 (0.7)	0.9 (1.5)	2.1 (1.3)	3.3 (1.0)	9.961 (0.000)	A E
d8	1.2 (1.4)	2.0 (1.5)	2.2 (2.4)	5.6 (2.7)	6.3 (2.4)	11.709 (0.000)	A,B,C D,E
d9	0.5 (0.5)	1.2 (1.0)	1.8 (1.2)	3.4 (0.7)	4.0 (0.0)	27.219 (0.000)	A D,E
Total	14.8 (13.1)	35.3 (15.4)	46.5 (31.7)	90.5 (22.8)	116.8 (12.4)	34.917 (0.000)	A D,E

Values are means (SD). MACS: Manual Ability Classification System; d1, learning and apply knowledge; d2, general tasks and demands; d3, communication; d4, mobility; d5, self care; d6, domestic life; d7, interpersonal interactions and relationships; d8, major life areas; d9, community, social, and civic life

in handling, and manipulating objects^{6,9}). In this study, the GMFM scores declined significantly when compared by MACS level: 92.6 ± 7.3 (MACS level I), 81.9 ± 17.5 (MACS level II), 60.9 ± 21.7 (MACS level III), 27.3 ± 11.0 (MACS level IV), and 13.8 ± 9.1 (MACS level V). This indicates that the higher the functional ability of children with CP, the greater their gross motor functions. Similarly, lower functional ability is associated with lower mobility.

In this study, the following functions from the ICF-CY checklist were significantly different when compared by MACS level: mental functions (b1); sensory function and pain (b2); voice and speech functions (b3); functions of the digestive, metabolic, and endocrine systems (b5); genitourinary and reproductive functions (b6); and neuromusculoskeletal and movement-related functions (b7). However, functions of the cardiovascular, hematological, immunological, and respiratory systems (b4) and functions of the skin and related structures (b8) did not show significant differences by MACS level. This suggests that the functional differences of children with CP depend on whether or not the functional motions are voluntary.

Arnaud et al.¹³) reported that physical activity is closely related to not only social activities but also social function. In this study, the activity and participation data from the ICF-CY checklist significantly differed by MACS level. This suggests that the degree of functioning, which depends on the degree of the disability, significantly influences the activity and participation of children in society and school and at home. These findings correspond to the findings of previous research.

Altogether, these findings suggest that in school-aged children with CP, the extents of functioning, activity, and participation all depend on the ability of the children to handle and manipulate objects (MACS level). Furthermore, the functioning of such children affects their activity level and degree of participation. However, because of our small sample size, it cannot be assumed that this sample is representative of the general population. This study only compared GMFM scores, function, standards of activity, and participation using a cross-sectional design. In addition, each MACS level had a different number of subjects, with some better represented than others. Therefore, we hope

that future studies will use MACS level groups of similar size, conduct correlation analyses for each of the items, and further attempt to identify effective intervention methods for functional improvement.

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