

Original Article

Mediating effects of the ICF domain of function and the gross motor function measure on the ICF domains of activity, and participation in children with cerebral palsy

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Abstract. [Purpose] This study aimed to evaluate the mediating effect of gross motor function, measured using the Gross Motor Function Measure (GMFM) and of general function, measured using the International Classification of Functioning, Disability and Health-Child and Youth Check List (ICF-CY), on the ICF domains of activity and participation in children with cerebral palsy (CP). [Subjects] Ninety-five children with CP, from Seoul, Korea, participated in the study. [Methods] The GMFM was administered in its entirety to patients without orthoses or mobility aids. The ICF-CY was used to evaluate the degree of disability and health of subjects. [Results] GMFM score and ICF-CY function were negatively correlated to ICF-CY activity and participation. ICF-CY partially mediated the effects of the GMFM on activity and participation. [Conclusion] When establishing a treatment plan for a child with CP, limitations in activity and participation, as described by the ICF-CY, should be considered in addition to the child's physical abilities and development. In addition, the treatment plan should focus on increasing the child's activity and participation level, as well as his/her physical level.

Key words: Cerebral palsy, Gross Motor Function Measure, International Classification of Functioning

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INTRODUCTION

Although school attendance provides a number of educational and social benefits to children with cerebral palsy (CP), the majority of these children face significant obstacles to participation in activities¹⁾. Children with disabilities have less physical abilities and fitness than their able-bodied peers and, as a result, have less experience in participating in play activities with their peers. Impairment in a child's capacity for physical movement, therefore, is an important factor, which limits, not only activities and participation in society, but also his/her level of quality of life²⁾. Basic ability to interact with people and to adapt to environments is another factor that limits activity and participation. Motor disability in children with CP causes limitation in physical activity and in general experience. In the long term, this can result in developmental delays in sensory function, cognition, formation of movement pattern, as well as in the develop-

ment of social stages³⁾. Impairment in postural control leads to diminished ability to adapt to sensory-motor learning in diverse environments⁴⁾. Therefore, children have different participation levels in daily activities depending on their level of physical function^{5, 6)}, which limits their activities in the community to varying degrees^{7, 8)}. Various factors influence the limitations of a child with CP in participating in activities of daily living⁹⁾ such as extent of impairment, age, and self-care abilities¹⁰⁾.

The purpose of treatment for a child with CP is to facilitate motor and functional development. The aim of our study was to investigate the association between scores on the Gross Motor Function Measure (GMFM) and a measure of general function, assessed using the International Classification of Functioning, Disability and Health-Child and Youth Check List (ICF-CY), on a child's activities and participation. The International Classification of Functioning, Disability and Health (ICF) was developed by the World Health Organization, and the ICF-CY is a modified version of the ICF which addresses the health, education, and social participation of children and young people. The ICF-CY defines activity as a personal task or behavior, while participation is defined by involvement in actual situations of daily living¹¹⁾. Specifically, in this study, we evaluated the mediating effect of gross motor function, measured by the GMFM, and of the 8 items of function on the ICF-CY, on the 9 sub-items of

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Table 1. The main difference of variables according to the general characteristics (N=95)

Variables		GMFM	ICF sub-item function	ICF sub-item activity and participation
Gender	Male (n=61)	64.7 (27.3)	27.9 (14.9)	51.7 (39.9)
	Female (n=34)	74.4 (25.5)	22.3 (18.0)	42.6 (42.2)
Types of CP	Spastic (n=86), a	71.1 (24.9)**, [†]	25.3 (16.0)	45.2 (39.7)*, [†]
	Hypotonic (n=4), b	34.5 (31.6)	29.3 (18.1)	93.0 (28.9)
	Mixed (n=5), c	45.0 (34.3)	32.4 (19.6)	68.4 (47.4)
Paralyzed types	Quadriplegia (n=13), a	31.2 (21.9)	38.9 (16.5)**, [‡]	88.2 (31.4)***, [‡]
	Diplegia (n=71), b	70.9 (22.8)	24.8 (15.8)	45.5 (39.9)
	Hemiplegia (n=11), c	94.0 (5.6)***, [§]	17.7 (9.2)	20.3 (17.2)

^a M (SD); *p<0.05, **p<0.01, ***p<0.001 means a significant difference between groups; § mean that 'a' is a significant difference than 'b' and 'c' (a<b<c); [†] mean that 'a' is a significant difference than 'b' (a>b); [‡] mean that 'a' is a significant difference than 'b' and 'c' (a>b, c)

activities and participation on the ICF-CY. This information would be important to establish realistic treatment goal and intervention plan.

SUBJECTS AND METHODS

Ninety-five children with CP, in Seoul, participated in this study. Children were excluded if they had undergone: orthopedic surgery or nerve amputation (neurotmesis) surgery less than 6 months prior to the start of the study, if they had received botulinum-toxin or baclofen treatment 3 months prior to the start, and if they suffered from epilepsy¹²⁾. The present study was approved by Sahmyook University Institutional Review Board (SYUIRB2015-28) and the objective of the study and its requirements were explained to the subjects, and all participants provided written parental consent; thus, the rights of human subjects were protected.

The general characteristics of the subjects, including scores on GMFM, ICF-CY function domain, and ICF-CY activity, and participation domain, are listed in Table 1. There were no gender-related effects on all study variables.

The GMFM was used to assess subjects' gross motor function. The GMFM consists of 5 dimensions: (A) lying and rolling, (B) sitting, (C) crawling and kneeling, (D) standing, and (E) walking, running, and jumping. It is recommended that the GMFM first be administered in its entirety to patients without orthoses or mobility aids. To determine the final GMFM score, percent scores were calculated for each dimensions and averaged to obtain a total test percentage score¹³⁾. The GMFM has demonstrated intra-rater ($r=0.77$, $r=0.88$) and inter-rater ($r=0.68$) reliability^{13, 14)}.

The ICF-CY Check List was used to evaluate the degree of disability and health of the subjects. The ICF-CY Check List is a summary version of the total ICF-CY, which includes the main core sections evaluating the health and disability of children and youth. Our study provides results for the ICF-CY domains of body function, activities, and participation for children, 7 to 12 years old, with CP. The domain of body function consists of 8 items: mental function; sensory function and pain; voice and speech function; function of the cardiovascular, hematological, immunological, and respiratory systems; functions of the digestive, metabolic,

endocrine, genitourinary, and reproductive systems; neuromusculoskeletal and movement-related functions; and functions of the skin and related structures. The domain of activities and participation evaluates the following 9 items: 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) life. Each section is scored from '0' to '4'.

All statistical analyzes were performed using SPSS statistical software, version 21.0. Means (SD) were calculated for outcome variables. Measured outcomes were evaluated relative to subjects' characteristics using t-test, analysis of variance (ANOVA), and post-hoc Scheffe test. The correlation between measured variables was evaluated by Pearson's Product-Moment Correlation, and mediated effects were verified through hierarchical regression analysis. A stepwise regression analysis was performed to investigate the effect of GMFM and sub-items of function, activities, and participation. Results were considered significant at $p<0.05$.

RESULTS

The correlation between the GMFM and ICF-CY function scores and the ICF-CY sub-items for activity and participation are reported in Table 2. The GMFM score negatively correlated to ICF-CY scores of function ($r = -0.71$, $p < 0.001$) and scores of activities and participation ($r = -0.78$, $p < 0.001$). ICF-CY function was strongly correlated to ICF-CY scores for activities and participation ($r = 0.87$, $p < 0.001$).

The mediating effects of ICF-CY function on the association between GMFM and ICF-CY activity and participation scores are reported in Table 3. In the first step of the logistic regression, gross motor function was identified as an independent predictor variable of ICF-CY function score ($\beta = -0.71$, $p < 0.001$). In the second step of the analysis, ICF-CY function was found to be an independent predictor variables of ICF-CY activity and participation scores ($\beta = -0.78$, $p < 0.001$). When scores for the GMFM and ICF-CY function were combined in the third step of the analysis, ICF-CY function was found to be a significant mediating

Table 2. The correlation among GMFM, ICF function, and ICF activities and participations ($N=95$)

	ICF activities and participations										
	GMFM	Total score	Studying knowledge	General task	Communication	Movement	Self management	Family life	Personal relations	Living territory	Community
GMFM	1.0	-0.8***	-0.7***	-0.7***	-0.6***	-0.8***	-0.8***	-0.7***	-0.5***	-0.6***	-0.8***
ICF function	-0.7***	0.9***	0.7***	0.8***	0.8***	0.9***	0.9***	0.8***	0.7***	0.8***	0.7***
Mental	-0.7***	0.9***	0.7***	0.8***	0.8***	0.8***	0.8***	0.8***	0.7***	0.8***	0.7***
Sensory f	-0.4***	0.5***	0.5***	0.4***	0.5***	0.4***	0.5***	0.3**	0.5***	0.5***	0.4***
Speech	-0.6***	0.7***	0.7***	0.6***	0.8***	0.4***	0.6***	0.4**	0.5***	0.5***	0.5***
Cardiovascular	-0.2	0.2*	0.3*	0.1	0.3*	0.1	0.2	0.1	0.1	0.2*	0.1
Digestive	-0.5***	0.5***	0.5***	0.4***	0.5***	0.3**	0.4***	0.3*	0.4***	0.3**	0.4***
Urinary	-0.3**	0.3**	0.3**	0.2*	0.3**	0.2	0.2*	0.1	0.2	0.1	0.2*
Neuromuscle	-0.5***	0.7***	0.4***	0.6***	0.4***	0.8***	0.7***	0.8***	0.5***	0.6***	0.6***
Skin	-0.1	0.2	0.2	0.1	0.2*	0.1	0.1	0.0	0.1	0.1	0.1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3. Mediating effects of ICF sub-item Function in the relationship between GMFM and ICF sub-item activity and participation ($N=95$)

Stages	Route	b	β	R^2	F
1	GMFM \rightarrow ICF function	-0.42	-0.71***	0.497	92.047***
2	GMFM \rightarrow ICF activity and participation	-1.18	-0.78***	0.612	146.802***
3	GMFM \rightarrow ICF activity and participation	-0.51	-0.34***	0.812	265.019***
	ICF function \rightarrow ICF activity and participation	1.59	0.63***		

*** $p < 0.001$

variable of activity and participation ($\beta = 0.63$, $p < 0.001$). In this step, the GMFM score was also found to have a significant mediating effect on activity and participation scores, but to a lesser degree than in step 2 ($\beta = -0.34$, $p < 0.001$). Therefore, ICF-CY function is a partial mediator between the GMFM and the ICF-CY domain of activity and participation. The Sobel test was performed to verify the strength of this partial mediation (z-value of -6.893 , $p < 0.001$). Taking into consideration the mediating effect of ICF-CY function, the direct effect of gross motor function on activity and participation was -0.34 , its indirect effect, -0.44 , and its total effect, -0.78 . The multi-collinearity between GMFM score and ICF-CY function was analyzed, with results of 1.99 indicating absence of multi-collinearity between these measures. With a 2.05 Durbin-Watson value calculated, independence of the error terms for the two measures was assumed. GMFM scores and the ICF-CY function predicted scores on the ICF-CY activity and participation items ($R^2 = 0.812$, $F = 198.596$, $p < 0.001$).

DISCUSSION

This study investigated the relationship of the score on the GMFM and ICF-CY function of school-age children with CP to that of the ICF-CY scores for activity and participation, with the aim of informing intervention goals, treatment strategies, and contributing, in general, to improving the rehabilitation for children with CP. The movement disorder

of CP leads to restriction in physical activity and experience with exercise. In addition, CP causes delays to the development of sensory or perceptual function, the formation of movement concept, and social development. In the long run, CP produces not only a disorder of movement development, but also restriction in the participation in several activities⁷. It is well recognized that restrictions in participation and activities vary with the extent of disability⁵.

Our study group included children with different types of movement disorders resulting from CP: spastic type, mixed type, and hypotonic type. It is considered that each of these different levels of movement disorder would have a major impact on activities and participation in daily living¹⁵.

Post-hoc analysis of our results indicated that higher scores on the GMFM and ICF-CY domains of activity and participation for children with a spastic type of CP, compared to children with hypotonia. This indicates that the movement disorder of spasticity supports a higher participation at school and society that the movement disorder of hypotonia. GMFM scores varied by spastic CP types ($F=27.682$, $p < 0.001$), with higher scores for hemiplegia, followed by diplegia and quadriplegia. In fact, scores on ICF-CY items of activity ($F=6.461$, $p < 0.01$) and participation ($F=10.897$, $p < 0.001$) were significantly lower for children with quadriplegia. ICF-CY function, used in this study, includes not only motor function, but also a holistic view of function that includes physical, mental, sensory, and digestive system function. Again, on this holistic scale of function, outcomes

were better for children with hemiplegia, compared to those with hemiplegia and quadriplegia.

The limitations of children with CP to participation in activities of daily living are multifactorial in nature⁹). This is why we used both the GMFM and ICF-CY to investigate factors that lead to limitation in community-based activity and participation. In addition, we specifically investigated the relationship between the sub-domains of the GMFM¹⁶) and the 8 sub-items of ICF-CY function: learning and applying knowledge, general tasks and demands, communication, movement, self-care, home living, interpersonal relationships, major life areas, community life, and social life to explore the impact of disability on the child's civic life. This study investigated whether the ICF-CY function mediated effects of gross motor function on activity and participation. Mediating effects were evaluated through the hierarchical regression analysis; in all three steps of the analysis, we evaluated the effects of identified independent variables, as well as evaluating mediating effects. In hierarchical regression analysis, in-putting parameters at the same time as the independent variable in step 3 allows us to determine the significance of the direct effect of the independent variable on the dependent variables; if the effect of the independent variable is not significant, then effects are considered to be mediated. If its effect is less than step 2, but was still significantly, the effect is determined to be partial mediated. Using this approach in our study, we identified both gross motor function and ICF-CY function to be predictive of ICF-CY activity and participation. However, the effects of gross motor function were partially mediated by ICF-CY function. Therefore, GMFM scores will have both a direct and an indirect relationship to activity and participation.

The results of this study show that ICF-CY function partially mediates the effects of gross motor function on activity and participation in children with CP. A child with CP, depending on the extent of damage, will experience varying levels of restrictions to participation in activities of daily living⁵). All components of ICF-CY function will have a significant impact on a child's gross motor function, activity, and participation. Therefore, intervention should target the affected components of ICF-CY function, rather than on gross motor function alone. Therefore, when establishing a treatment plan for a child with CP, it is important to identify, not only the child's physical ability and development, but also factors restricting activity and participation, using the ICF-CY function as a reference.

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