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The relationship among the functional levels, dyskinetic movements and participation in children with dyskinetic cerebral palsy

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Abstract

Background & Objective: This study aimed to investigate the relationship between the Gross Motor Function Classification System (GMFCS), the Manual Ability Classification System (MACS), the Eating and Drinking Ability Classification System (EDACS), the Communication Function Classification System (CFCS), dyskinetic movements and participation levels in children with dyskinetic cerebral palsy (DCP) to attain a comprehensive functional profile of DCP. *Methods:* Forty children with DCP aged between 5-18 years were included. Functional classification systems: GMFCS, MACS, CFCS, EDACS levels investigated. The Dyskinesia Impairment Scale (DIS) was used for evaluate dyskinetic movements: dystonia and choreoathetosis. Assessment of Life-Habits-Questionnaire (LIFE-H) was used for evaluate participation. Spearman's correlation test was used to evaluate the relationship among functional classification levels, DIS subscales and LIFE-H subdomains. Multivariate simple linear regression, backward model was used to explain relations between LIFE-H subdomains, DIS subscales, GMFCS, MACS, EDACS and CFCS. Results: The mean age was 12.88±4.57 years. Correlations were found between GMFCS-MACS, GMFCS-EDACS, MACS-EDACS, CFCS-MACS, GMFCS-CFCS and EDACS-CFCS ($p<0.05$); between GMFCS and dystonia upper extremity, dystonia lower extremity total score, dystonia total score ($p<0.05$); between MACS and dystonia upper extremity, dystonia lower extremity total score, dystonia total score, and dystonia mouth total score ($p<0.05$). LIFE-H Social-Roles Total Score, Daily-Living-Activities Total Score, LIFE-H-Total-Score were correlated with GMFCS, MACS, EDACS and CFCS ($p<0.05$). The results of regression analysis showed GMFCS and MACS levels are strong predictors of participations ($p<0.05$).
Conclusions: To plan participatory intervention programs, it is important to understand the levels of participation and differences among children with DCP subtypes according to the ICF framework.

Keywords: Activity, body structure and function, cerebral palsy, dyskinesia, participation.

INTRODUCTION

Cerebral palsy (CP) is a persistent group of disorders occur in fetal or infant brain, which are non-progressive, cause activity limitation, and affect the development of movement and posture.[1] CP is the most frequent cause of physical disability in childhood.[2] According to the previous surveillance studies, Dyskinetic CP (DCP) is the second common subtype, affecting 10–20% of children with CP.[3,4] Previous studies indicate that severe motor impairment[5] and intellectual disability are more frequent in DCP than in other subtypes.[6,7] DCP, characterized by abnormal postures or movements associated with impaired muscle tone regulation, movement control, and coordination and comprises two major movement disorder patterns: dystonia and choreoathetosis.[8,9]

Dystonia defines abnormal postures and repetitive movements due to intermittent muscle contractions, commonly triggered by voluntary movements which may be aggravated by, fatigue, pain, and others.[8,10] Choreoathetosis is a hyperkinetic movement disorder with fluctuating tone and can be further subdivided into chorea and athetosis. Choreatic movements are rapid, involuntary, jerky, and often fragmented, whereas athetosis is characterized by involuntary, discrete, slow, continuously changing, writhing,

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or contorting movements.[11] Both movement disorders are independently present in DCP.[11]

Functional classification systems play an important role in planning management of CP, to distinguish characteristics of functional abilities and to set treatment/rehabilitation goals.[12] The most commonly used classification systems in CP are the Gross-Motor-Function-Classification-System (GMFCS)[13], the Manual-Ability-Classification-System (MACS)[14], the Communication-Function-Classification-System (CFCS)[15], the Eating-and-Drinking-Ability-Classification-System (EDACS)[16], Viking-Speech-Scale (VSS)[17] and more recently Visual-Function-Classification-System (VFCS).[18]

Although DCP is the second-largest CP group in the total CP population[3], few studies have investigated functional classification in DCP. Furthermore, a comprehensive functional profile for DCP is important for establishing targeted interventions.[2]

Hidecker *et al*. first reported a moderate-to-good correlation between the gross motor, manual, and communication abilities of children and young people with CP.[19] Additionally, Gunel *et al*. documented good correlation between GMFCS-MACS in children with spastic CP.[20] On the other hand, the lack of information on DCP requires caution in generalizing the findings to the population of DCP.[2] Monbaliu *et al.* investigated functional outcomes in DCP, and they found more than 50% of the participants exhibited the highest limitation levels in GMFCS, MACS, and VSS, and a relationship among the classification scales.[2]

The International Classification of Functioning, Disability, and Health (ICF) provides a useful framework for therapists to better understand the health, functionality, activity, participation, contextual factors, and the impact of dyskinesia and effectively manage it[21], and today, participation, has received increasing attention as the ultimate outcome of rehabilitation.[22] Activities in the context of daily life are closely related to participation. Previous studies have shown that increasing motor impairments and activity limitations in children with CP increases the degree of restriction on participation.[23,24]

Despite of its importance, the participation levels according to the severity in DCP is less investigated. Monbaliu *et al*. related dystonia and choreoathetosis with participation, and they found dystonia has a higher impact on participation than choreoathetosis.[25] On the other hand, relationship of participation and functioning in DCP is still unclear. Therefore, this study was conducted with the aims of (1) examine the domains of participation; (2) the relationship among the functional classification levels, and with domains participation in children and adolescents with DCP; (3) to predict role of dyskinetic movements and functional levels on participation. We hypothesized that in children and adolescents with DCP, there is a relationship among functional classification levels, dyskinetic movements and domains of participation.

METHODS

Study population

All participants were recruited from five special education and rehabilitation centers between December 2018-June 2019. Children who were classified DCP according to the Surveillance of CP in Europe[26] were included to the study. The Hypertonia Assessment Tool was used to distinguish dystonia from spasticity.[27] Inclusion criteria were (1) aged between 5 and 18 years, (2) diagnosed with DCP, and (3) able to understand test instructions. Exclusion criteria were having orthopedic or neurosurgical interventions, or spinal fusion in the previous year and have spasticity. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Hacettepe University (GO-18/861) and written informed consent was obtained from all participants or the participant's parents.

Measurements

The Dyskinesia Impairment Scale (DIS) was administered to assess dystonia and choreoathetosis. The DIS is a reliable and valid video-based scale that consists of two subscales: the dystonia subscale (DSS), and the choreoathetosis subscale (CSS). They distinctly assess dystonia and choreoathetosis of the eyes, mouth, neck, trunk, and extremities at rest and during activity. Items are scored on a five-point ordinal scale. Higher scores correspond to increasing severity of dystonia and choreoathetosis. Every participant was given a score for DSS and CSS.[10] All participants videotaped with the DIS video protocol in their natural environment.

Evaluation of functional classification levels

The valid and reliable Turkish versions of GMFCS[28], MACS[29], CFCS[30], and EDACS[31] were

used to classify the functional classification levels.

Gross Motor Function Classification System (GMFCS): The GMFCS classifies motor impairment in children with CP. The differences between levels are based on functional constraints, the need for hand-held mobility aids or wheeled mobility devices.[14,28]

Manual Abilities Classification System (MACS): The MACS classifies the manual skills of children with CP between the ages of 4–18 years, such as grasping and releasing objects in daily life within five levels.[15,29]

Eating and Drinking Abilities Classification System (EDACS): The EDACS classifies eating and drinking function in children with CP into five levels. EDACS is used to differentiate and classify the daily eating and drinking habits in individuals with CP.[16,31]

Communication Function Classification System (CFCS): The purpose of CFCS is to classify the daily communication performance of individuals with CP into 5 levels (Level I–V).[17,30]

Evaluation of participation

Participation was measured using the valid and reliable Turkish form of Assessment of Life Habits (LIFE-H)[32] as parent proxy. The LIFE-H documents the manner in which people carry out daily activities and social roles over 12 domains. Item scores are converted into raw scores ranging from 0 (lowest participation) to 10 (maximal participation). Its construct is very broad, covering all life domains or situations in which a person may be involved in his/her own environment. The LIFE-H consists of 12 categories, namely nutrition, fitness, personal care, communication, housing, mobility, responsibilities, interpersonal relationships, community life, education, employment, and recreation.[33]

Statistics

The Statistical Package for Social Sciences (SPSS) software version 21.0 was used. Normality distribution was evaluated using the Shapiro-Kolmogorov test. The Spearman correlation test was used to evaluate the correlations. The correlation co-efficient and its meaning are as follows: no correlation between 0 and 0.25, fair correlation between 0.25 and 0.50, moderate to good correlation between 0.50 and 0.75, and excellent correlation over 0.75.[34] Multivariate backward modelling linear regression model was used to explain relations between LIFE-H subdomains, DIS subscales, GMFCS, MACS, EDACS and CFCS. Each LIFE-H subdomains modelled as the dependent variable and DIS subscales, GMFCS, MACS, EDACS and CFCS were the predictor variable.

RESULTS

Forty participants (23 males, 17 females) between 5-18 years (mean age 12.88±4.57 years) fulfilled the criteria. Individual characteristics are provided in Table 1.

Functional profile

The functional profile according to the classification systems is presented in Table 1. The statistical comparison of dystonia and choreoathetosis dominant subtype in different body regions, with the median and interquartile range of the outcome measures on the DIS is presented in Table 2.

Correlations among classification systems

A positive correlation was found between GMFCS-MACS ($r=0.81$; $p<0.05$) GMFCS-EDACS ($r=0.73$, $p<0.05$); MACS-EDACS ($r=0.67$, $p<0.05$); CFCS-MACS ($r=0.55$, $p<0.05$), GMFCS-CFCS ($r=0.35$, $p<0.05$), and EDACS-CFCS ($r=0.30$, $p<0.05$).

Findings of the correlations between functional classification levels and body parts in DIS

There was a fair positive correlation between GMFCS and dystonia upper extremity, dystonia lower extremity total score, dystonia total score and dystonia mouth total score ($r=0.45$, 0.44, 0.46, 0.31respectively, $p<0.05$). Positive correlations were found between MACS and dystonia upper extremity, dystonia lower extremity total score, dystonia total score, total score ($r=0.50$, 0.45, 0.50, respectively, $p<0.05$). No correlation was found between EDACS, CFCS and DIS scores except dystonia and choreoathetosis mouth score ($r=0.40$, -0.33, $p<0.05$) with EDACS (Table 3).

Findings of the relationship between functional classification levels and participation

Negative correlations were found between GMFCS and LIFE-H's Social-Roles Total Score, Daily-Living-Activities Total Score, LIFE-H Total Score, and Housing, Mobility, Nutrition, Fitness,

Table 1: Participants' mean age, anthropometric measurements and their functional classification systems levels

Socio-demographic Characteristics		Dyskinetic cerebral palsy Mean±Standard Deviation
Age (years)		12.87±4.56
Body Weight (kg)		46.85±20.36
Body Mass Index (BMI)		21.88±4.09
Height (cm)		142.65±29.72
Classification Systems		**Dyskinetic cerebral palsy n (%)**
GMFCS	Level I	9 (22.5)
	Level II	9 (22.5)
	Level III	7 (17.5)
	Level IV	4 (10)
	Level V	11 (27.5)
MACS	Level I	2 (5)
	Level II	16 (40)
	Level III	7 (17.5)
	Level IV	11 (27.5)
	Level V	4 (10)
EDACS	Level I	17 (42.5)
	Level II	14 (35)
	Level III	7 (17.5)
	Level IV	2 (5)
	Level V	0 (0)
CFCS	Level I	3 (7,5)
	Level II	18 (45)
	Level III	12 (30)
	Level IV	6 (15)
	Level V	1 (2.5)

CFCS: Communication Function Classification System; EDACS: Eating and Drinking Ability Classification System; GMFCS: Gross Motor Function Classification System; MACS: Manual Ability Classification System.

Personal care, Communication, Responsibilities, Interpersonal-Relations, Community life, Recreation subscales (r=-0.7, -0.55, -0.64, -0.69, -0.62, -0.69, -0.58, -0.45, -0.45, 0.46, -0.54, -0.51, -0.47, -0.54 respectively; $p<0.05$). Similarly, negative correlations were found between MACS and LIFE-H's Social Roles Total Score, Daily-Living-Activities Total Score, LIFE-H Total Score, and Nutrition, Housing, Interpersonal-Relations, Personal care, Communication, Mobility, Responsibilities, Community life, Recreation, Fitness, Education subscales (r=-0.61, -0.69, -0.64, -0.71, -0.62, -0.69, -0.56, -0.43, -0.49, -0.49, -0.41, -0.47, -0.38, -0.39; $p<0.05$).

Negative correlations were found between EDACS and LIFE-H's Daily-Living-Activities Total Score, Social-Roles Total Score and LIFE-H Total Score Personal care, Communication, Mobility, Responsibilities, Interpersonal-Relations, Education, Fitness, Community life, Employment, Recreation subscales (r=-0.59, -0.57, -0.58, -0.49, -0.45, -0.43, 0.53, -0.45, -0.46, -0.33, -0.33, - 0.34, -0.34 respectively; $p<0.05$). Similarly, negative correlations found between CFCS and LIFE-H's Daily-Living-Activities Total Score, Social-Roles Total Score, LIFE-H Total Score, and Interpersonal-Relations, Nutrition, Personal care, Communication, Mobility, Education, Recreation subscales (r= -0.38, -0.43,

Table 2: Median, interquartile range and range of the Dyskinesia Impairment Scale of the participants

	Median %	Interquartile Range	Range (Min-Max)
DIS Dystonia Subscale			
Total D	7.46	0-41.40	0-85.76
Total D $_{\text{UPPER LIMBS}}$	4.16	0-25.00	0-85.41
Total D $_{\text{UPPER LIMBS PROX}}$	4.16	0-15.62	0-95.83
Total D $_{\text{UPPER LIMBS DIST}}$	2.08	0-40.62	0-79.16
Total D $_{\text{LOWER LIMBS}}$	8.33	0-27.08	0-89.58
Total D $_{\text{LOWER LIMBS PROX}}$	6.24	0-19.78	0-91.66
Total D $_{\text{LOWER LIMBS DIST}}$	8.33	0-36.45	0-100
Total D $_{\text{TRUNK}}$	8.33	0-50.00	0-95.83
Total D $_{\text{NECK}}$	12.49	0-47.91	0-100
Total D $_{\text{Mouth}}$	8.33	0-25.00	0-100
Total D $_{\text{EYE}}$	12.5	0-22.91	0-100
DIS Choreoathetosis Subscale			
Total CA	18.57	0-36.88	0-88.19
Total CA $_{\text{UPPER LIMBS}}$	16.66	0-33.33	0-91.66
Total CA $_{\text{UPPER LIMBS PROX}}$	8.33	0-42.70	0-91.66
Total CA $_{\text{UPPER LIMBS DIST}}$	18.74	0-44.78	0-91.66
Total CA $_{\text{LOWER LIMBS}}$	16.66	0-30.98	0-89.58
Total CA $_{\text{LOWER LIMBS PROX}}$	8.33	0-23.95	0-87.50
Total CA $_{\text{LOWER LIMBS DIST}}$	22.91	0-41.66	0-91.66
Total CA $_{\text{TRUNK}}$	8.33	0-25.00	0-83.33
Total CA $_{\text{NECK}}$	16.66	0-39.57	0-83.33
Total CA $_{\text{Mouth}}$	20.83	0-47.91	0-100
Total CA $_{\text{EYE}}$	20.83	0-47.91	0-100

CA: Choreoathetosis; D: Dystonia; DIS: Dyskinesia Impairment Scale; DIST: distal; Max: maximum; Min: minimum; PROX: proximal.

-0.46, -0.40, -0.36, -0.35, -0.32, -0.33, -0.39 p<0.05) (Table 4).

Results of regression analyses

The results obtained from the backward modelling linear regression analysis showed that among the subcategories of LIFE-H, gross motor function level (Beta=0.39, p=0.03) and manual ability level (Beta=3.39, p=0.04) were strong predictors of LIFE-H Total Score, and explained 52% of the variance; gross motor function level (Beta=0.64, p<0.01) was strong predictors of LIFE-H Daily-Living-Activities that explained 41% of the variance; manual ability level (Beta=0.42, p=0.03) were strong predictors of LIFE-H Social-Roles, and explained 53% of the variance remained in the model finally (Table 5).

The results obtained from the backward modelling linear regression analysis showed that among the subcategories of LIFE-H, DIS Choreoathetosis Total (Beta=1.31, p<0.01) and DIS Dystonia Total (Beta=0.81, p=0.06) were strong predictors of LIFE-H Total Score; DIS Dystonia Total (Beta=1.29, p<0.01), and explained 29% of the variance. DIS Choreoathetosis Upper Limbs Total (Beta=0.52, p<0.01) and DIS Dystonia Upper Limbs (Beta=0.87, p=0.04) were strong predictors of LIFE-H Daily Living Activities explained 30% of the variance. DIS Choreoathetosis Total (Beta=0.39, p=0.02) and DIS Dystonia Total (Beta=1.25, p=0.01) were

Table 3: Relationship among GMFCS, MACS, EDACS, CFCS and DIS body parts in children with dyskinetic cerebral palsy

	GMFCS		MACS		EDACS		CFCS	
	R_s (95% CI)	p	R_s (95% CI)	p	R_s (95% CI)	p	R_s (95% CI)	p
DIS Dystonia Subscale								
Total D	0.46 (0.16-0.70)	**0.003**	0.50 (0.18-0.75)	**0.001**	0.26 (-0.08-0.56)	0.09	0.31 (-0.02-0.58)	**0.05**
Total D $_{\text{UPPER LIMBS}}$	0.45 (0.16-0.67)	**0.004**	0.50 (0.19-0.72)	**0.001**	0.27 (-0.03-0.56)	0.08	0.25 (-0.08-0.54)	0.10
Total D $_{\text{LOWER LIMBS}}$	0.44 (0.10-0.69)	**0.004**	0.45 (0.15-0.69)	**0.003**	0.26 (-0.07-0.54)	0.10	0.23 (-0.07-0.52)	0.14
Total D $_{\text{Mouth}}$	0.31 (0-0.57)	**0.04**	0.18 (-0.11-0.50)	0.24	0.40 (0.11-0.66)	**0.009**	0.22 (-0.14-0.55)	0.16
Total D $_{\text{Trunk}}$	0.53 (0.25-0.75)	**0.001**	0.48 (0.22-0.69)	**0.002**	0.39 (0.09-0.65)	**0.01**	0.15 (-0.17-0.44)	0.34
DIS Choreoathetosis Subscale								
Total CA	-0.06 (-0.39-0.28)	0.68	-0.16 (-0.47-0.18)	0.31	0.08 (-0.25-0.43)	0.58	-0.10 (-0.43-0.23)	0.52
Total CA $_{\text{UPPER LIMBS}}$	0.03 (-0.30-0.37)	0.81	-0.04 (-0.36-0.28)	0.77	0.14 (-0.18-0.46)	0.38	-0.11 (-0.42-0.20)	0.47
Total CA$_{\text{LOWER IMBS}}$	-0.04 (-0.35-0.28)	0.77	-0.11 (-0.42-0.24)	0.47	0.06 (-0.26-0.41)	0.69	-0.004 (-0.33-0.31)	0.98
Total CA $_{\text{Mouth}}$	-0.26 (-0.53-0.02)	0.09	-0.07 (-0.45-0.27)	0.63	-0.33 (-0.61- -0.02)	**0.03**	-0.18 (-0.52-0.15)	0.24
Total CA $_{\text{Trunk}}$	-0.009 (-0.33-0.30)	0.95	-0.05 (-0.38-0.27)	0.74	0.15 (-0.20-0.49)	0.35	-0.05 (-0.39-0.30)	0.72

CA: Choreoathetosis; CFCS: Communication Function Classification System; D: Dystonia; DIS: Dyskinesia Impairment Scale; EDACS: Eating and Drinking Ability Classification System; GMFCS: Gross Motor Function Classification System; MACS: Manual Ability Classification System; p: Statistical error; r: correlation coefficient; Spearman correlation test.

strong predictors of LIFE-H Social Roles, explained 24% of the variance remained in the model finally (Table 5).

DISCUSSION

This study was aimed at advancing our insights in the functional profile of individuals with DCP and to determine the relationship among domains of participation levels and the functional classification levels.

To date, few studies have investigated the relationship between functional classification levels and participation in the ICF framework. In the community-based study investigated DCP, by Himmelmann *et al*., 8% of the individuals were GMFCS Level I–II, 12% GMFCS Level III, 21% GMFCS Level IV, 58% GMFCS Level V.[35] Similarly, in the SCPE study covering European countries, it was reported that 59% of the children with DCP were ambulated with wheelchair (GMFCS Level IV–V), 24% were walking with assistance (GMFCS Level III), and 16% were able to walk without assistance (Level I–II).[5] More recently, Monbaliu *et al*. investigated functional outcomes of individuals with DCP, they found majority of the children was in level IV-V according to GMFCS and MACS, and better functional abilities were seen in EDACS and CFCS.[2] In current study, we found 37.5% of the participants in level IV-V according to GMFCS, as well as in MACS. In general, Himmelman *et al*. found majority of children severely affected in terms of gross motor function and manual abilities, similar to current study; conversely, participants showed better in communication function and eating and drinking abilities (levels I–III)[5]. Although, motor activity plays role on eating, drinking and vocalization; EDACS and CFCS describe individual's ability to safely eat and

Table 4: Relationship among GMFCS, MACS, EDACS, CFCS and LIFE-H in children with dyskinetic cerebral palsy

	GMFCS		MACS		EDACS		CFCS	
LIFE-H	**R_s (95% CI)**	**p**	**R_s (95% CI)**	**p**	**R_s (95%CI)**	**p**	**R_s (95% CI)**	**p**
Nutrition	-0.58 (-0.77 - -0.30)	**0.001**	-0.61 (-0.78- -0.36)	**0.001**	-0.67 (-0.80- -0.48)	**0.001**	-0.38 (-0.62- -0.10)	**0.01**
Fitness	-0.45 (-0.68- -0.15)	**0.003**	-0.38 (-0.63- -0.09)	**0.015**	-0.33 (-0.61- -0.02)	**0.034**	-0.11 (-0.40-0.20)	**0.48**
Personal care	-0.45 (-0.68 - -0.16)	**0.003**	-0.56 (-0.76- -0.29)	**0.001**	-0.49 (-0.73- -0.20)	**0.001**	-0.38 (-0.58- -0.10)	**0.01**
Communication	-0.46 (-0.68 - -0.16)	**0.003**	-0.43 (-0.70- -0.13)	**0.005**	-0.45 (-0.70- -18)	**0.003**	-0.36 (-0.60- -04)	**0.02**
Housing	-0.69 (-0.84 - -0.45)	**0.001**	-0.69 (-0.83- -0.46)	**0.001**	-0.63 (-0.78- -0.41)	**0.001**	-0.31 (-0.54- -0.03)	**0.05**
Mobility	-0.62 (-0.82- -0.35)	**0.001**	-0.49 (-0.71- -0.21)	**0.001**	-0.43 (-0.73- -0.27)	**0.005**	-0.35 (-0.62- -0.03)	**0.02**
Responsibilities	-0.54 (-0.74- -0.25)	**0.001**	-0.49 (-0.71- -0.21)	**0.001**	-0.53 (-0.73- -0.27)	**0.001**	-0.24 (-0.55-0.08)	**0.13**
Interpersonal-Relations	-0.51 (-0.72 - -0.22)	**0.001**	-0.62 (-0.81- -0.37)	**0.001**	-0.45 (-0.67- -0.17)	**0.003**	-0.46 (-0.71- -0.13)	**0.003**
Community life	-0.47 (-0.69 - -0.17)	**0.002**	-0.41 (-0.66- -0.11)	**0.007**	-0.33 (-0.57- -0.03)	**0.03**	-0.17 (-0.48- -0.14)	**0.28**
Education	-0.34 (-0.60 - -0.02)	**0.029**	-0.39 (-0.65- -0.05)	**0.01**	-0.46 (-0.68- -0.19)	**0.003**	-0.32 (-0.57- -0.03)	**0.04**
Employment	-0.21 (-0.49- 0.10)	**0.17**	-0.15 (-0.42-0.16)	**0.34**	-0.34 (-0.58- -0.04)	**0.02**	-0.26 (-0.53-0.04)	**0.10**
Recreation	-0.54 (-0.76 - -0.26)	**0.001**	-0.47 (-0.70- -0.19)	**0.002**	-0.34 (-0.60- -0.07)	**0.02**	-0.33 (-0.61- -0.02)	**0.03**
Daily-Living-Activities Total Score	-0,64 (-0.81- -0,39)	**0.001**	-0.64 (-0.80- -0.40)	**0.007**	-0.59 (-0.75- -0.36)	**0.001**	-0.39 (-0.64- -0.11)	**0.012**
Social Roles Total Score	-0.71 (-0.83- -0.53)	**0.001**	-0.71 (-0.84- --0.50)	**0.001**	-0.57 (-0.78- -0.36)	**0.001**	-0.43 (-0.66- -0.15)	**0.005**
LIFE-H Total Score	-0.69 (-0.83 - -0.46)	**0.001**	-0.69 (-0.84- -0.47)	**0.001**	-0.58 (-0.74- -0.37)	**0.001**	-0.40 (-0.65- -0.13)	**0.009**

CFCS: Communication Function Classification System; CI: Confidence Interval; EDAC: Eating and Drinking Ability Classification System; GMFCS: Gross Motor Function Classification System; LIFE-H: Assessment of life habits questionnaire; MACS: Manual Ability Classification System; p: Statistical error; R_s: correlation coefficient; Spearman correlation test.

drink, and to engage in communication function regardless of the communication method used. Therefore, this distinction could be explained by how the components of the scales are assessed.

Hidecker *et al*.[19] and Elze *et al*.[36] found a moderate-to-good relationship between GMFCS, MACS, and CFCS. The main difference with the current study is based on the distribution of participants; the sample of Hidecker *et al*.[19] consisted of participants with different types of CP. No distinction was made between the motor characteristics. Another study by Beckung and Hagberg[37], which included 23 participants with CP, 11 percent of whom had DCP, showed that gross motor ability was strongly associated with bimanual function. According to previous studies, considering the excellent correlation (r=0.81), the relationship between GMFCS and MACS in the current study was predictable.

Table 5: Results of regression analyses

Dependent variable	Independent variable	B	Std. Error	Beta	p	R^2
Model: Participation and Functional Classifications						
LIFE-H Total Score	**Model 1: Multiple linear regression (backward modeling)**					
	Step 1					
	Constant	79.637	8.285		<0.01	
	GMFCS	.-4.769	3.016	-0.342	0.123	
	MACS	-5.511	4.373	-0.293	0.216	0.539
	CFCS	-2.530	3.332	-0.109	0.453	
	EDACS	-2.376	3.877	-0.099	0.453	
	Step 3					
	Constant	75.508	6.816		<0.01	
	GMFCS	-5.064	2.706	-0.363	**0.039**	0.527
	MACS	-7.518	3.655	-3.399	**0.047**	
LIFE-H Daily Living Activities	**Model 2: Multiple linear regression (backward modeling)**					
	Step 1					
	Constant	50.263	5.559		<0.01	
	GMFCS	-2.692	2.024	-0.308	0.192	
	MACS	-2.703	2.934	-0.229	0.363	0.472
	CFCS	-1.652	2.236	-0.114	0.465	
	EDACS	-2.348	2.601	-0.155	0.373	
	Step 4					
	Constant	42.281	3.635		<0.01	0.412
	GMFCS	-5.616	1.087	-0.642	**<0.01**	
LIFE-H Social Roles	**Model 3: Multiple linear regression (backward modeling)**					
	Step 1					
	Constant	29.374	3.529		<0.01	
	GMFCS	-2.078	1.285	-0.354	0.115	
	MACS	-2.808	1.285	-0.355	0.141	0.527
	CFCS	-0.878	1.419	-0.090	0.540	
	EDACS	-0.878	1.419	-0.003	0.987	
	Step 3					
	Constant	28.330	2.885		<0.01	0.531
	MACS	-3.381	1.547	-0.427	**0.035**	
Model: Participation and Dyskinetic Movements						
LIFE-H Total Score	**Model 1: Multiple linear regression (backward modeling)**					
	Step 1					
	Constant	58.345	6.712		<0.01	0.315
	DIS Choreoathetosis T	-0.153	0.169	-0.439	0.374	
	DIS Dystonia Total	-0.305	0.237	-1.083	0.207	
	DIS Choreoathetosis UL T	-0.229	0.304	-0.252	0.456	
	DIS Dystonia UL Total	0.634	0.392	0.798	0.115	
	DIS Choreoathetosis LL T	0.181	0.344	0.187	0.602	
	DIS Dystonia LL Total	-0.167	0.411	-0.214	0.687	
	Step 4					
	Constant	58.766	6.488		<0.01	0.296
	DIS Choreoathetosis T	-0.176	0.059	-0.506	**0.005**	
	DIS Dystonia Total	-0.372	0.127	-1.319	**0.006**	

LIFE-H Daily Living Activities	**Model 2: Multiple linear regression (backward modeling)**				
	Step 1				
	Constant	38.421	4.167	<0.01	
	DIS Choreoathetosis Total	-0.105	0.105	-0.483	0.324	
	DIS Dystonia Total	-0.183	0.147	-1.034	0.222	
	DIS Choreoathetosis UL T	-0.195	0.189	-0.341	0.310	0.330
	DIS Dystonia UL Total	0.395	0.243	0.794	0.114	
	DIS Choreoathetosis LL T	0.176	0.214	0.290	0.416	
	DIS Dystonia LL Total	-0.110	0.255	-0.225	0.669	
	Step 4				
	Constant	37.172	3.583	<0.01	
	DIS Dystonia Total	-0.229	0.080	-1.294	**0.007**	0.305
	DIS Choreoathetosis UL T	-0.300	0.091	-0.526	**0.002**	
	DIS Dystonia UL Total	0.437	0.216	0.877	**0.041**	
LIFE-H Social Roles	**Model 1: Multiple linear regression (backward modeling)**				
	Step 1				
	Constant	19.925	2.952	<0.01	
	DIS Choreoathetosis Total	-0.047	0.075	-0.323	0.530	
	DIS Dystonia Total	-0.122	0.104	-1.032	0.249	
	DIS Choreoathetosis UL T	-0.035	0.134	-0.091	0.797	0.252
	DIS Dystonia UL Total	0.238	0.172	0.714	0.176	
	DIS Choreoathetosis LL T	0.005	0.151	0.013	0.971	
	DIS Dystonia LL Total	-0.057	0.181	-0.174	0.755	
	Step 4				
	Constant	20.029	2.819	<0.01	
	DIS Choreoathetosis T	-0.058	0.026	-0.398	**0.029**	0.248
	DIS Dystonia Total	-0.148	0.055	-1.251	**0.011**	
	DIS Dystonia UL Total	0.255	0.149	0.762	0.097	

B, unstandardized regression coefficient; CFCS, Communication Function Classification System; EDACS, Eating and Drinking Ability Classification System; GMFCS, Gross Motor Function Classification System; LIFE-H, Assessment of life habits questionnaire; MACS, Manual Ability Classification System; Std. Error, standard error; ß, standardized Beta

Considering the positive relationships among GMFCS, MACS, and CFCS[19,38,39] and between EDACS and GMFCS[31], our results show the impact of each functional outcome on areas of participation among children with DCP. In our study, children with DCP found that gross motor function was positively correlated with fine motor function, eating, and drinking skills, and participation in feeding and housing outcomes, but not with communication abilities.

The low-medium relationship and significant difference in distribution between the two classification systems classifies gross motor skills and manual function, and CFCS and EDACS, underline the need to include eating, drinking, and communication as part of functional assessment in individuals with DCP. The difference also may reflect the severity in DCP, which is more obvious in motor skills rather than communication, eating, and drinking abilities. The communication of children who have severe motor disorders is often nonverbal and idiosyncratic, and is sometimes pre-intentional.[40] Therefore, clinicians can also elicit communication skills not observed in everyday conversation, so assessments to develop these skills are important.

We found relationship between GMFCS, MACS, EDACS, and LIFE-H's nutritional and housing subscale, and total scores in individuals with DCP. In addition, a good correlation was found between the GMFCS and the leisure activities subscale of the LIFE-H. In the ability to perform leisure activities, DCP is closely related to the body structure and function of the individual. There was also a significant correlation between MACS and participation to the self-care. In a study conducted by Klingels *et al*. on spastic CP, the level of function increased as hand skills, such as grasping and selective distal movements improved.[41] Based on this point,

we think that the upper extremity functions in dyskinetic individuals affect body function, and in turn, personal care, which is the sub-parameter of participation.

In the study conducted by Smits *et al*. in children with CP, no statistically significant correlation was found between the level of GMFCS and the level of mobility in daily life, according to the type of motor impairment, but a positive correlation was found between DCP and mobility in our study.[42] Although Imms *et al*. reported contradictory results[43], Morris *et al,* found that scores for the Activities Scale for Kids and Lifestyle Assessment Questionnaire Physical Independence and Mobility domains were predicted well by children's movement and manual disabilities, as current study.[44]

As gross motor skills increase in DCP cases, physical fitness and social life sub-parameters of participation also increase, as shown by Orlin *et al*.[45] in their study with a large sample of young people with CP in which the relationship between GMFCS and the degree of participation decreases as the dysfunction increases. This result indicates the importance of enhancing and maintaining motor functionality for physical fitness and social life, as Rosenbaum and Gorter underlined within the F-word concept for childhood disabilities.[46]

As reported by Vanmechelen *et al*.[47] our results suggest that the presence of choreoathetosis movements may have different participatory effects and may need to be differentiated for further specification of treatment management plans.

Palisano *et al*.[48] investigated participation and GMFCS with regression analysis; and they found that gross motor function levels predict participation similar to current study. On the other hand, the main difference with the current study, Palisano *et al*.[48] included all types of CP, whereas the current study included only DCP. Amini *et al*.[49] analyzed clinical types of CP, and in children with cerebral palsy, they found as Palisano *et al*'s[48] study and current study, GMFCS levels have a role on participation. Therefore, findings of current study suggest that dyskinetic movements which plays role on severity of CP have an impact on participation.

Pashmdarfard *et al.*[50] investigated relationship between participation with Children Participation Assessment Scale-Parent version and Manual Ability Level. Activity of Daily Living, Instrumental Activity of Daily Living, play, leisure, education, work, social participation, rest/sleep evaluate the fields. Both in Pashmdarfard's[50] and current study found that MACS levels predict participation in different life areas. Since, in current study we found that MACS predicts total score of LIFE-H, and only predictor of participation into the social roles, with total scores of choreoathetosis and dystonia, we strongly suggest to give more attention to manual abilities in clinical interventions aiming to enhance participation.

This study has limitations. First, the age range of 5-18 years is quite broad, and we did not differentiate between age groups. Further studies suggest that investigating different age groups may help determine how participation levels change according to age group. Second, we would have liked to use the VSS[18], but we did not use, because it did not have Turkish validity and reliability as well as VFCS[19] at the time of our study. Third, health care professionals should also recognize and consider the interaction of person and environment when addressing issues related to participation.

In conclusion, this study is one of the few studies in the literature that examines individuals with DCP including severe forms of CP and makes a detailed assessment of dystonia and choreoathetosis dominant subtype in individuals with DCP for functional classification levels and participation results.

To plan participatory intervention programs, it is important to understand the levels of participation and differences among children with DCP subtypes according to the ICF framework.

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