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EXAMINING THE PREDICTIVE VALUE OF FUNCTIONAL CLASSIFICATION SYSTEMS FOR MOBILITY IN CHILDREN WITH CEREBRAL PALSY

Veysel Akduman, Harran University, Faculty of Health Sciences, Şanlıurfa, Türkiye,

Gönül Acar, Marmara University, Faculty of Health Sciences, İstanbul, Türkiye

Corresponding Author : *Veysel Akduman, u_weys@hotmail.com*

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Abstract

This study aimed to investigate, in children with cerebral palsy (CP), the relationships between mobility performance, assessed using four classification systems (GMFCS, MACS, CFCS, and BFMF), and the Functional Mobility Scale (FMS), and to evaluate the ability of these systems to predict mobility. A total of 100 children with cerebral palsy aged 8-14 years were included in the study. The distributions of GMFCS, MACS, CFCS, and BFMF levels and their relationships with FMS scores at distances of 5 m, 50 m, and 500 m were analyzed. The classification system levels were converted into dummy variables and included in multiple regression models. According to multiple linear regression analyses, GMFCS levels were significant predictors of FMS scores at all distances, whereas MACS, CFCS, and BFMF levels did not significantly contribute to the models. Kruskal–Wallis tests based on GMFCS levels revealed significant differences at all distances. In addition, correlation analysis revealed positive correlations among all classification systems. The strongest correlation was observed between GMFCS and BFMF ($r = 0.571$, $p < 0.001$), and the weakest was observed between CFCS and MACS ($r = 0.231$, $p = 0.021$). The explanatory powers of the regression models for 5-m, 50-m, and 500-m distances were 56.1%, 57.2%, and 40.6% (Adjusted R^2), respectively. These findings demonstrate that GMFCS is the most effective classification system for predicting mobility and may be prioritized in clinical assessments. Moreover, the significant and positive correlations among the classification systems suggest they may be used complementarily in clinical practice.

Keywords: Cerebral palsy, Classification systems, Functional mobility scale

INTRODUCTION

Cerebral Palsy (CP) is defined as "a group of permanent disorders, attributed to non-progressive disturbances in the developing fetal or infant brain, that cause activity limitations in the development of movement and posture" (Sadowska, Sarecka-Hujar & Kopyta, 2020). CP is one of the most common causes of physical disability in childhood, with a prevalence of approximately 2–3 per 1,000 live births worldwide (Jiang, Yang, Chen, Song & Zhang, 2024). This neurodevelopmental condition is frequently accompanied by behavioral, communication, cognitive, and sensory problems and shows considerable clinical heterogeneity among individuals (Kwon, Yi, Kim, Chang & Kwon, 2013; Rosenbaum et al., 2007).

CP has a heterogeneous clinical picture (Rosenbaum et al., 2007), and even among children with similar diagnoses, there may be significant differences in functional abilities. This heterogeneity in functional abilities poses major challenges to implementing effective rehabilitation for children and adolescents with CP (Almasri, Saleh, Abu-Dahab, Malkawi & Nordmark, 2018). Classification systems are useful for grouping children with CP into more homogeneous categories based on their functional abilities (Nishibu, Seino & Himuro, 2023). Therefore, various classification systems have been developed to objectively assess multidimensional aspects of functioning. Almost all classification systems define individuals' ability to perform activities of daily living independently across five levels (I: best– V: worst) (Akpinar, Tezel, Eliasson & İçağasıoğlu, 2010; Dere, Serel Arslan & Alemdaroğlu-Gürbüz, 2023; Mutlu et al., 2018; Seyhan-Bıyık et al., 2024). These systems facilitate communication by grouping individuals into more homogeneous categories, optimize service planning, and provide a common terminology for research purposes (Nishibu et al., 2023). The most widely used of these are the Manual Ability Classification System (MACS), which evaluates the adequacy of hand use in activities of daily living (Akpinar et al., 2010); the Bimanual Fine Motor Function (BFMF) Classification, which is based on symmetrical use of both hands (Seyhan-Bıyık et al., 2024); the Communication Function Classification System (CFCS) (Mutlu et al., 2018); and the Gross Motor Function Classification System (GMFCS), which categorizes gross motor mobility levels (Dere et al., 2023).

Although the GMFCS classifies an individual's gross motor capacity generally, it may not always accurately capture mobility skills across environments or functional abilities demonstrated in daily life (Bjornson, Zhou, Stevenson, Christakis & Abbuhl, 2014; Palisano, Rosenbaum, Bartlett & Livingston, 2008). This highlights that the GMFCS, while evaluating motor capacity, may not fully represent an individual's functional mobility in real-world settings on its own. Therefore, approaches that focus solely on gross motor performance may be insufficient to fully understand overall functional abilities (Skoutelis et al., 2022). Clinicians may find it challenging—or even unfeasible—to accurately classify children who use various mobility aids at different times and over varying distances using the GMFCS alone (Graham, 2007). To address these limitations, clinicians working with children with CP often employ the Functional Mobility Scale (FMS) as a complementary tool to the GMFCS, allowing for a more detailed depiction of functional mobility across different settings and distances (Harvey et al., 2009).

Functional mobility refers to an individual's ability to move independently within a range of environmental contexts and across multiple distances. The Functional Mobility Scale (FMS), used in this study, serves as a practical, performance-based assessment of mobility capacity at standardized distances of 5, 50, and 500 meters (Karataş et al., 2024). While the GMFCS classifies an individual's general level of gross motor function, the FMS captures actual performance within specific real-world contexts. It offers a functional perspective for rehabilitation planning by identifying the extent to which an individual is able to participate in daily activities (Graham, 2007; Karataş et al., 2024).

The present study aims to investigate the effects of the GMFCS, MACS, BFMF, and CFCS classification systems on functional mobility, as measured by the Functional Mobility Scale (FMS), which assesses real-life movement capacity over various distances in children with cerebral palsy. Through a multidimensional approach, the study seeks to identify key functional components that influence mobility and to inform clinical assessment and intervention strategies.

MATERIAL AND METHOD

Study Desing

This cross-sectional study was conducted from June to July 2025 among children diagnosed with cerebral palsy (CP) receiving services at the Özel Çağdaş Special Education and Rehabilitation Center. Ethical approval was obtained from the Harran University Social Sciences Ethics Committee (Approval No: 2025/224). All procedures were carried out in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all participants.

All assessments were performed during a single session in a quiet and distraction-free environment, prior to the children's routine physiotherapy sessions at the rehabilitation center. Breaks were provided as needed to ensure participant comfort and compliance.

Participants

A total of 100 children aged between 8 and 14 years, all diagnosed with cerebral palsy by a pediatric neurologist or rehabilitation specialist, were included in the study. All participants regularly attended Özel Çağdaş Special Education and Rehabilitation Center and were actively enrolled in either mainstream or special education programs during the data collection period. Inclusion criteria were as follows: a confirmed diagnosis of CP by a neurologist or pediatric rehabilitation specialist; aged 8–14 years; enrollment in formal education (mainstream or special); and no cognitive impairment severe enough to hinder communication or the understanding of instructions. Children were excluded if they had moderate-to-severe intellectual disability or significant cognitive impairment diagnosed by a medical specialist; a history of orthopedic surgery; any concomitant disease during the study period; sensory impairments, such as hearing or vision loss, that would interfere with assessment; or were not regularly attending or receiving therapy-only services at a special education and rehabilitation center.

Sample Size

In this study, an a priori power analysis was conducted to determine the minimum sample size required for a multiple linear regression model evaluating the effects of four functional classification systems (GMFCS, MACS, BFMF, and CFCS) on functional mobility (FMS score) in children with cerebral palsy. Since each of these classification systems consists of five ordinal levels (Level I-V) and is included in the model as a categorical variable, dummy coding was applied. Thus, each variable contributed 4 predictors (k-1 dummy variables), resulting in a total of 16 predictors in the regression model (4 systems × 4 dummy codes) (Field, 2013). To estimate the required sample size, Cohen's f^2 effect size was calculated from a previous study of children with cerebral palsy that reported a minimum correlation coefficient of r = 0.50 between classification systems (Compagnone et al., 2014). The correlation coefficient was converted into an R^2 value using the formula:

$$R2= r2= 0.25$$

Subsequently, Cohen's f^2 was computed using the following transformation:

$$f^2 = R^2 / (1 - R^2) = 0.25 / 0.75 = 0.33$$

This represents a large effect size according to Cohen's classification (Cohen, 1988). Using G*Power 3.1.9.7 software, the required sample size for a linear multiple regression with (Faul, Erdfelder, Lang & Buchner, 2007): Effect size (f^2) = 0.33; α error probability = 0.05; Power (1-β) = 0.90; number of predictors = 16. The required sample size was calculated to be at least 88 participants. Therefore, a sample of n ≥ 88 was considered sufficient to detect a statistically significant effect with adequate power.

Assessment

The demographic and clinical characteristics of all participants were collected using a sociodemographic information form developed by the researchers. The children's motor function levels and hand use abilities were assessed using three standardized classification systems.

The Gross Motor Function Classification System (GMFCS) was used to assess the children's gross motor capacity and motor function. The GMFCS categorizes functional mobility across five levels, with Level I indicating minimal impairment (walking, running, and jumping independently, but with some limitations in speed or balance) and Level V indicating severe limitations (poor head control and reliance on wheelchair mobility). The Turkish version of the GMFCS is commonly used in clinical settings and has demonstrated high test-retest reliability (ICC = 0.94) (El et al., 2012).

The Manual Ability Classification System (MACS) was applied to assess how effectively children use their hands during daily activities. The MACS comprises five levels, ranging from Level I (able to handle objects easily) to Level V (unable to handle objects, or able to handle them only with severe limitations). The classification was based on both clinical observation and parent reports. The Turkish version of MACS also shows strong test-retest reliability, with an ICC of 0.96 (Akpinar et al., 2010).

The Bimanual Fine Motor Function (BFMF) classification was used to assess the fine motor skills of each hand. Each hand is graded on a five-level scale, where Level I indicates near-normal function and Level V represents no functional use. The BFMF system is widely used in European CP follow-up studies as a standard for documenting hand function. In this study, the best BFMF level was recorded for the child's dominant and affected hands (Seyhan-Bıyık et al., 2024).

The Communication Function Classification System (CFCS) was used to assess the children's communication performance in daily life. This system categorizes communication ability into five levels, from Level I (effective and timely as both sender and receiver with familiar and unfamiliar partners) to Level V (rarely effective even with familiar partners). Levels are determined based on the child's speed of communication, consistency in sending and receiving messages, and the familiarity of the communication partner. The CFCS classification was performed by a pediatric physiotherapist using clinical observation and parental input. The Turkish version of the CFCS has demonstrated good test-retest reliability, with an ICC of 0.82 (Mutlu et al., 2018).

The Functional Mobility Scale (FMS) was employed to evaluate children's mobility at three distances: 5 meters (home), 50 meters (school), and 500 meters (community). For each distance, the child's functional mobility was classified on a scale from 1 to 6, where "1" indicates use of a wheelchair, "2" indicates use of a walker, "3" indicates use of two crutches, "4" indicates use of one crutch or cane, "5" indicates independent walking on flat surfaces, and "6" indicates independent walking on all surfaces. Where applicable, codes "C" (crawling) and "N" (not applicable) were also used. In this study, FMS scores for each distance were obtained through interviews with both the child and their parents. The FMS has demonstrated excellent reliability across all three distances, with ICC values of 0.966 for 5 meters, 0.954 for 50 meters, and 0.969 for 500 meters (Karataş, 2018).

Statistical Analysis

The data obtained in the study were analyzed using IBM SPSS Statistics 25.0 software. The normality of the data distribution was assessed using the Shapiro-Wilk test. Descriptive statistics for continuous variables are presented as the arithmetic mean, standard deviation, minimum, and maximum. Categorical data are reported as frequencies and percentages (%).

Spearman's correlation coefficients were calculated to examine the relationships between functional mobility scores (FMS at 5 m, 50 m, and 500 m) and classification systems (GMFCS, MACS, BFMF, CFCS). Multiple linear regression analyses were conducted to investigate the predictive effect of classification system levels on functional mobility. In the regression models, the levels of GMFCS, MACS, BFMF, and CFCS were included as categorical variables, with dummy coding applied to each. The explanatory power of the models was evaluated using adjusted R^2, while model fit was assessed via the Akaike Information Criterion (AIC). Assumptions of multiple linear regression were assessed using variance inflation factors (VIFs).

The non-parametric Kruskal-Wallis test was employed to assess whether FMS scores differed significantly across GMFCS levels. For variables showing significant differences, pairwise comparisons between groups were performed using the Mann-Whitney U test. To minimize the risk of Type I error due to multiple comparisons, the Bonferroni correction was applied, and the adjusted significance level was set at $p < 0.005$ instead of 0.05. For all statistical

In the analyses, a significance level of $p < 0.05$ was adopted; however, for tests involving Bonferroni correction, the Bonferroni-adjusted p-value threshold was used.

RESULT

This study included 100 children with cerebral palsy, comprising 42 boys and 58 girls. The mean age of the participants was 11.82 ± 1.50 years. The mean body weight and height were 40.68 ± 9.18 kgand 143.74 ± 15.69 cm, respectively (Table 1).

Table 1. Descriptive Characteristics of the Participants (n=100)

Variable	Mean ± SD / n (%)
Gender (Boy/Girl)	42 (42%) / 58 (58%)
Age, mean ± SD	11.82 ± 1.50
Weight, mean ± SD	40.68 ± 9.18 kg
Height, mean ± SD	143.74 ± 15.69 cm

cm= Centimeter; kg= Kilogram; SD: Standard Deviation

The distribution of participants according to four motor function classification systems is presented in Figure 1. According to the GMFCS system, the largest number of children were classified in Level II (n = 38), while the smallest number were classified in Level V (n = 5). According to the CFCS classification, the majority of participants were classified at Level I (n = 78). For the MACS, most children were categorized as Level II (n=59). Similarly, under the BFMF classification, more than half of the participants (n = 51) were placed in Level II.

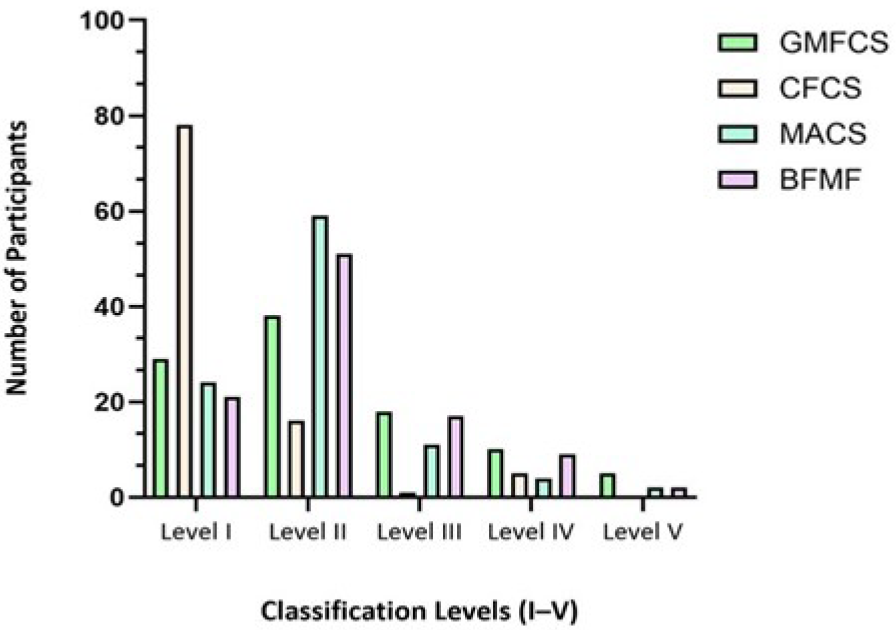

Figure 1. Distribution of the participants across classification levels

In the correlation analysis conducted to evaluate the relationships between the classification systems (Table 2), a strong positive correlation was found between GMFCS and BFMF ($r = 0.571$, $p < 0.001$). The correlations between GMFCS and MACS ($r = 0.397$, $p < 0.001$) and between GMFCS and CFCS ($r = 0.248$, $p = 0.013$) were also statistically significant. Additionally, significant relationships were observed among the other classification systems: CFCS and

BFMF showed a moderate positive correlation (r = 0.315, p = 0.001), and MACS and BFMF showed a moderate-to-strong positive correlation (r = 0.535, p < 0.001).

Table 2. Correlation Coefficients Between Functional Mobility Scores and Classification Systems

Variables		CFCS	MACS	BFMF
GMFCS	r	.248*	.397*	.571*
	p-value	.013	<.001	<.001
CFCS	r		.231*	.315*
	p-value		.021	.001
MACS	r			.535*
	p-value			<.001

GMFCS = Gross Motor Function Classification System; BFMF = Bimanual Fine Motor Function; MACS = Manual Ability Classification System; CFCS = Communication Function Classification System; r = Correlation coefficient; * p-value : <0.05

In the regression analyses (Table 3), the predictive effect of GMFCS levels on FMS scores was modeled separately at three distances. In the FMS 5-meter model, GMFCS Levels III, IV, and V had a significant negative effect on FMS scores ($p < 0.05$). A similar pattern was observed in the FMS 50-meter and 500-meter models. In particular, GMFCS Levels IV and V showed significant negative β coefficients across all distances (e.g., GMFCS Level V for FMS 50 m: β = -0.443, $p < 0.001$). The adjusted R^2 value was 0.572 for FMS 5 m.

Values were 0.561 for FMS 50 m and 0.406 for FMS 500 m, indicating that the models' explanatory power was moderate to high. The CFCS, MACS, and BFMF variables did not demonstrate significant predictive effects in any of the models ($p > 0.05$). Examination of the VIF values related to multicollinearity indicated that all values were below 5, confirming that the model assumptions were satisfied.

Table 3. Regression Model Predictors for Functional Mobility Scores (5 m, 50 m, 500 m) Based on Classification Systems

Model-1 FMS 5m	**β**	**Lower Limit**	**Upper Limit**	**p**	**VIF**
GMFCS Level2	-.050	-.750	.403	.551	1.634
GMFCS Level3	-.168	-1.440	-.024	**.043***	1.543
GMFCS Level4	-.537	-4.038	-1.959	**<.001***	2.028
GMFCS Level5	-.628	-6.420	-3.228	**<.001***	2.525
CFCS Level2	.053	-.385	.873	.443	1.111
CFCS Level3	.015	-1.990	2.487	.826	1.035
CFCS Level4	.001	-1.600	1.609	.995	2.551
MACS Level2	-.034	-.671	.440	.680	1.558
MACS Level3	-.121	-1.603	.306	.180	1.861
MACS Level4	-.117	-2.476	.471	.180	1.740
MACS Level5	-.166	-4.223	.243	.080	2.039
BFMF Level2	.002	-.601	.614	.983	1.924
BFMF Level3	.031	-.699	.979	.741	2.073
BFMF Level4	.076	-.908	1.795	.516	3.121
BFMF Level5	.107	-1.595	4.158	.378	3.383
Adjusted R^2= .561			AIC= 71,875		
Model-2 FMS 50m					

GMFCS Level2	-.229	-1.639	-.244	**.009***	1.634
GMFCS Level3	-.523	-3.578	-1.865	**<.001***	1.543
GMFCS Level4	-.605	-5.288	-2.773	**<.001***	2.028
GMFCS Level5	-.443	-5.993	-2.131	**<.001***	2.525
CFCS Level2	-.008	-.806	.717	.908	1.111
CFCS Level3	.010	-2.511	2.905	.885	1.035
CFCS Level4	.039	-1.580	2.302	.713	2.551
MACS Level2	.040	-.511	.833	.635	1.558
MACS Level3	-.075	-1.635	.674	.410	1.861
MACS Level4	-.032	-2.111	1.455	.715	1.740
MACS Level5	-.030	-3.129	2.274	.754	2.039
BFMF Level2	.011	-.690	.780	.903	1.924
BFMF Level3	-.040	-1.230	.800	.674	2.073
BFMF Level4	-.056	-2.026	1.244	.636	3.121
BFMF Level5	-.032	-3.939	3.021	.794	3.383
Adjusted R^2= .572			AIC= 33,795		
Model-3 FMS 500m					
GMFCS Level2	-.387	-2.329	-.760	**<.001***	1.634
GMFCS Level3	-.582	-3.892	-1.965	**<.001***	1.543
GMFCS Level4	-.463	-4.398	-1.570	**<.001***	2.028
GMFCS Level5	-.333	-5.126	-.783	**.008***	2.525
CFCS Level2	.009	-.806	.906	.908	1.111
CFCS Level3	.064	-1.793	4.298	.416	1.035
CFCS Level4	.098	-1.313	3.053	.430	2.551
MACS Level2	-.020	-.833	.679	.839	1.558
MACS Level3	-.098	-1.904	.694	.357	1.861
MACS Level4	-.018	-2.184	1.826	.859	1.740
MACS Level5	-.054	-3.791	2.285	.623	2.039
BFMF Level2	-.107	-1.242	.411	.321	1.924
BFMF Level3	-.161	-1.969	.315	.153	2.073
BFMF Level4	-.093	-2.470	1.208	.497	3.121
BFMF Level5	-.089	-5.147	2.680	.532	3.383
Adjusted R^2= .406			AIC= 95,376		

*GMFCS = Gross Motor Function Classification System; BFMF = Bimanual Fine Motor Function; MACS = Manual Ability Classification System; CFCS = Communication Function Classification System; FMS = Functional Mobility Scale; m= meters; VIF = Variance Inflation Factor; Adjusted R² = Adjusted R-squared; β = Standardized regression coefficient; AIC = Akaike Information Criterion; * p-value : <0.05*

The results of the Kruskal-Wallis test, conducted to evaluate whether there were group differences in FMS scores based on GMFCS levels, are shown in Table 4. Significant differences across GMFCS levels were found in the FMS

5-m, 50-m, and 500-m scores (H = 51.455, 58.913, and 45.794, respectively; $p < 0.001$). The calculated eta squared (η^2) effect size were 0.499, 0.578, and 0.440, respectively, indicating that these differences reflected a large effect size.

Table 4. Kruskal-Wallis Test Results for Functional Mobility Scores According to GMFCS Levels

	H	p	Eta squared η^2
FMS 5m	51.455	**<.001***	0.499
FMS 50m	58,913	**<.001***	0.578
FMS 500m	45,794	**<.001***	0.440

GMFCS: Gross Motor Function Classification System; FMS: Functional Mobility Scale; η² = Eta squared (effect size); H = Kruskal-Wallis test statistic; p-value : <0,05.*

Table 5. Pairwise Comparisons of Functional Mobility Scores (5 m) Between GMFCS Levels (Mann-Whitney U Test with Bonferroni Correction)

GMFCS Groups (5 m)	Z	U	p (Bonferroni correction α < 0.005)
I - II	-2.014	478.50	0.044
I - III	-3.592	159.50	**0.000***
I - IV	–5.298	29.00	**0.000***
I - V	-5.745	0.00	**0.000***
II - III	-2.184	253.00	0.029
II - IV	-4.474	52.50	**0.000***
II - V	-4.748	2.50	**0.000***
III - IV	-2.665	38.00	0.008
III - V	-3.408	2.50	**0.001***
IV - V	-1.827	12.50	0.068

*Pairwise comparisons conducted using the Mann-Whitney U test. Bonferroni correction applied for multiple comparisons (adjusted significance level α = 0.005). Statistically significant differences after correction are indicated by an asterisk ().**

Pairwise comparisons using the Mann-Whitney U test revealed functional mobility scores at a 5-meter distance between GMFCS levels (Table 5). Bonferroni-corrected analyses revealed at the 5-meter distance ($p < 0.005$) between Level I and Levels III, IV, and V; between Level II and Levels IV and V; and between Levels III and V. Similarly, at the 50-meter distance, comparisons of Level I with the other levels, and of Level II with Levels III, IV, and V, yielded statistically significant differences (Supplementary Table 1). At the 500-meter distance, comparisons of Level I with Levels II, III, IV, and V were particularly significant. However, at this distance, some comparisons between Levels III, IV, and V did not reach statistical significance ($p > 0.005$; Supplementary Table 2).

DISCUSSION

Classification of functional levels of children with cerebral palsy (CP) across different domains is critical for clinical practice, particularly for individualized treatment planning and prognostic evaluations (Karahan & Orak, 2021). Multidimensional assessment of functional mobility in children with CP plays a key role in determining individualized rehabilitation goals (Erden & Korkmaz 2022). The classification systems developed for this purpose define key functional domains— such as movement, hand use, and communication— across five levels; they reflect the multidisciplinary nature of CP and are complementary to one another (Paulson & Vargus-Adams, 2017). However, these systems primarily assess capacity and may not fully capture the child's actual performance across various daily life environments (Karahan & Orak, 2021). Therefore, the performance-based FMS, which provides context-specific assessments and evaluates the child's mobility in different settings such as home, school, and community, serves as a complementary tool to these systems (Albalwi, Saleh, Alharbi, Al-Bakri & Alatawi, 2023; Karataş et al., 2024).

Our study revealed statistically significant positive correlations between GMFCS and BFMF, as well as between MACS and CFCS. Although the strength of these relationships varied across classification systems, GMFCS and BFMF showed stronger correlations, while MACS and CFCS showed moderate-to-low correlations. Similarly, the correlation between MACS and BFMF was relatively strong, whereas the correlation between MACS and CFCS was moderate.

These findings suggest that the classification systems complement one another, with each capturing distinct aspects of functional abilities (Hidecker et al., 2012; Martinec et al., 2021; Mutlu et al., 2018). Previous studies are consistent with these findings.

The correlation between GMFCS and MACS has generally been reported to be between

0.29 and 0.78, between GMFCS and BFMF between 0.47 and 0.85, and between GMFCS and CFCS approximately 0.47 (Günel, Mutlu, Tarsuslu & Livanelioğlu, 2009; Kurt, Ünsal Delialioğlu, Özel & Çulha, 2013; Unes et al., 2022). Correlation coefficients ranging from r =

Correlation coefficients (r) of 0.88–0.89 were observed between MACS and BFMF, and of 0.54–0.73 between MACS and CFCS (Hidecker et al., 2012). In addition, the positive relationship between CFCS and BFMF shows that the systems complement each other in the multidimensional assessment of functional abilities (Martinec et al., 2021). Although there are significant relationships between these systems, none of the correlation coefficients are very high ($rs > 0.80$), indicating that a single system is not sufficient to evaluate the functional level of children with CP and highlighting the need for a multi-system assessment approach (Hidecker et al., 2012; Riyahi, Rassafiani, Mehreban & Akbarfahimi, 2024).

In this study, we examined the effects of four classification systems on children's mobility performance, as measured by the FMS. The results revealed that only GMFCS levels were significantly associated with FMS scores. In contrast, the predictive power of MACS, BFMF, and CFCS for FMS was not statistically significant. This suggests that the structure of the GMFCS, which focuses on lower extremity function, is more directly aligned with a scale that assesses walking performance, such as the FMS (Burgess et al., 2022).

When the regression models are examined in detail, GMFCS levels significantly predict FMS scores at all three distances (5 m, 50 m, 500 m). However, the explanatory power of the model varies depending on the distance. In particular, the model developed for the intermediate distance of 50 meters demonstrated the highest explanatory power (Adjusted $R^2 = 0.561$; AIC = 71,875). This may suggest that children's walking abilities differ more markedly across GMFCS levels in larger indoor environments, such as schools. Although the model's explanatory power appears slightly higher at the short distance of 5 meters (Adjusted $R^2 = 0.572$; AIC = 33,795), the difference may not be clinically meaningful. This could be attributed to the fact that children with more severe motor impairments may still ambulate short distances indoors. Conversely, at the long distance of 500 m, GMFCS remains a significant predictor, although the model's explanatory power decreases (Adjusted $R^2 = 0.406$; AIC = 95,376).

This may be attributed to the clustering of mobility patterns among children with more severe motor limitations in the community, which reflects the limited variation in their ambulation capabilities. This finding is consistent with previous studies. Harvey et al. (2010) stated that the relationship between GMFCS and FMS was most clearly observed at the intermediate distance (Harvey, Morris, Graham, Wolfe & Baker, 2010). Similarly, Rethlefsen et al. (2022) reported that GMFCS was more effective in explaining mobility performance at 50 meters, but its explanatory power declined over longer distances. In the same study, the authors explained this by noting that children with severe motor impairments typically use wheelchairs for community mobility, resulting in relatively homogeneous mobility scores within this group (Rethlefsen, Hanson, Ciccodicola, Wren & Kay, 2022).

The results showed that FMS scores differed significantly among children at different GMFCS levels (all $p < 0.001$). Eta squared (η^2) values revealed that the effect of these differences was strong: $\eta^2 = 0.578$ for 50 meters, $\eta^2 = 0.499$ for 5 meters, and $\eta^2 = 0.440$ for

500 meters. These findings indicate that GMFCS levels not only provide a theoretical classification but also significantly reflect children's mobility performance in daily life (Harvey et al., 2010). The particularly pronounced differences at the middle distance suggest that GMFCS distinguishes levels of function more clearly in indoor environments, such as schools. The Kruskal-Wallis analysis confirms the significant predictive findings of the regression models, showing that FMS scores differ systematically across GMFCS levels. The consistency of these results, obtained across different statistical approaches, indicates that the GMFCS is a reliable reference point for explaining mobility levels.

On the other hand, in our study, the absence of a significant relationship between MACS, BFMF, and CFCS levels and FMS scores suggests that these systems are insufficient to predict ambulatory mobility performance directly. This result is closely related to the functional domains evaluated by these classification systems. MACS and BFMF focus on daily hand functions, such as upper extremity use and bimanual fine motor skills. These systems are generally observation-based and may be insufficient to fully reflect the child's context-specific movement behaviors, particularly lower-extremity-focused functions such as distance-related mobility (Bıyık & Günel 2024). CFCS, by contrast, is a system for classifying communication skills. While it may not directly influence physical performance such as walking, it may have an indirect impact through social participation, opportunities for interaction, and environmental factors (Hidecker et al., 2012; Burgess et al., 2023). Therefore, the weak relationship between CFCS and FMS is also an anticipated result from a measurement perspective. Similarly, some previous studies (Elze et al., 2016; Chagas et al., 2008) have highlighted the limitations of these systems in explaining mobility.

Limitations

Although it was conducted with careful planning and appropriate analyses, this study has some limitations. First, although the sample size was determined through a priori power analysis and found to be sufficient for the regression models, conducting the study at a single center may limit the generalizability of the findings to other sociocultural contexts or to broader CP populations. Therefore, studies with more diverse participant profiles and conducted in multiple centers are needed to confirm the generalizability of the findings. Although the FMS is a performance-based scale that assesses mobility in daily life data in this study were obtained from either children or their parents, depending on the age group. In younger children, assessments were primarily based on parental reports. This approach may compromise the accuracy of assessments due to subjectivity in reporting. In addition, the wide age range of participants may reduce the reliability of self-reports and limit the consistency of comparisons among children. Therefore, integrating scales such as FMS with more objective methods (e.g., wearable sensors or observation-based analyses) may enhance the reliability of the results.

Finally, the cross-sectional design of the study does not allow for inferences about cause-and-effect relationships. Prospective longitudinal studies are needed to explore how changes in classification systems over time influence functional mobility.

CONCLUSION

This study revealed that the GMFCS is the classification system that most strongly predicts functional mobility in children with CP. This relationship appears to be particularly pronounced at medium distances (e.g., 50 meters). Although the MACS, BFMF, and CFCS systems do not significantly predict FMS scores, they represent domains that may indirectly influence mobility performance. The limited contribution of these systems to gait-based outcomes reflects the multidimensional nature of motor function. Therefore, assessment approaches that consider the needs of children across various functional domains are gaining importance. In rehabilitation planning, incorporating performance-based scales such as the FMS alongside the GMFCS may help define more realistic goals for mobility in daily life. In future research, analyses involving larger samples and more diverse clinical groups may better elucidate the potential benefits of the integrated use of these classification systems.

Ethics Committee Approval: Ethical approval was obtained from the Harran University Social Sciences Ethics Committee (Approval No: 2025/224).

Informed Consent: Written informed consent was obtained from the parents or legal guardians of all participants.

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SUPPLEMENTARY DOCUMENT

Supplementary Table 1. Pairwise Comparisons of Functional Mobility Scores (50 m) Between GMFCS Levels (Mann-Whitney U Test with Bonferroni Correction)

GMFCS Groups (50 m)	Z	U	p (Bonferroni correction α < 0.005)
I - II	-3.201	322.00	**0.001***
I - III	-5.480	26.00	**0.000***
I - IV	-5.152	1.00	**0.000***
I - V	-4.152	0.000	**0.000***
II - III	-3.647	139.50	**0.000***
II - IV	-4.541	16.00	**0.000***
II - V	-3.526	5.00	**0.000***
III - IV	-3.046	30.00	**0.002***
III - V	-2.732	10.00	0.006
IV - V	-1.038	20.00	0.299

*Pairwise comparisons conducted using the Mann-Whitney U test. Bonferroni correction applied for multiple comparisons (adjusted significance level α = 0.005). Statistically significant differences after correction are indicated by an asterisk ().**

Supplementary Table 2. Pairwise Comparisons of Functional Mobility Scores (500 m) Between GMFCS Levels (Mann-Whitney U Test with Bonferroni Correction)

GMFCS Groups (500 m)	Z	U	P (Bonferroni correction α < 0.005)
I - II	-3.841	260.50	**0.000***
I - III	-4.859	49.00	**0.000***
I - IV	-4.240	20.00	**0.000***
I - V	-3.205	10.00	**0.001***
II - III	-3.139	176.50	**0.002***
II - IV	-3.299	70.00	**0.001***
II - V	-2.419	35.00	0.016
III - IV	-1.578	70.00	0.115
III - V	-1.130	35.00	0.258
IV - V	0.000	25.00	1.000

*Pairwise comparisons conducted using the Mann-Whitney U test. Bonferroni correction applied for multiple comparisons (adjusted significance level α = 0.005). Statistically significant differences after correction are indicated by an asterisk ().**