

GROSS AND FUNCTIONAL MOTOR IMPAIRMENT IN CHILDREN WITH CEREBRAL PALSY

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ABSTRACT

Background: Cerebral palsy (CP) represents a group of permanent disorders of movement and posture, frequently accompanied by disturbances in sensation, cognition, communication, and behavior. Functional classification systems such as the Gross Motor Function Classification System-Expanded and Revised (GMFCS-E&R) and the Manual Ability Classification System (MACS) provide standardized methods for assessing functional ability in children with CP. Understanding their correlation aids in comprehensive clinical assessment and rehabilitation planning. **Objective:** To determine the frequency of functional profiles of children with cerebral palsy based on GMFCS-E&R and MACS, and to evaluate the correlation between the two classification systems. **Study Design:** Cross-sectional study. **Settings:** Department of Pediatrics, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan. **Duration of Study:** February 2025 to May 2025. **Methods:** A total of 138 children diagnosed with cerebral palsy were enrolled after obtaining informed consent. Demographic and clinical characteristics were recorded. Each participant's motor and manual abilities were classified using GMFCS-E&R and MACS, respectively. Statistical analysis was performed using Spearman's correlation coefficient (r_s), and $p < 0.05$ was considered significant. **Results:** The median (IQR) age of the participants was 6 (4) years. Based on GMFCS-E&R, 17 (16.7%) children were classified at level I, 27 (26.5%) at level II, 24 (23.5%) at level III, 28 (27.5%) at level IV, and 6 (5.8%) at level V. According to MACS, 25 (24.5%) were at level I, 44 (43.2%) at level II, 15 (14.7%) at level III, 14 (13.7%) at level IV, and 4 (3.9%) at level V. A statistically significant positive correlation was observed between GMFCS-E&R and MACS ($r_s = 0.623$, $p < 0.001$). **Conclusion:** The majority of children with cerebral palsy demonstrated moderate functional impairment, predominantly classified within levels II–IV of both GMFCS-E&R and MACS. A strong positive correlation between the two systems underscores their concurrent validity and usefulness in multidisciplinary assessment and rehabilitation planning for children with CP..

Keywords: Cerebral Palsy, Classification Systems, Function

INTRODUCTION

A collection of movement and postural disorders that restrict activity and are brought on by non-progressive changes in the developing fetal or infant brain is referred to as "cerebral palsy" (CP). CP motor abnormalities are frequently accompanied by seizure disorder and/or impairments in sensation, perception, communication, cognition, and/or behavior. In most industrialized countries, the most frequent reason for children's physical disabilities is cerebral palsy, occurring in roughly two out of every 1000 live births (2).

The medical condition's heterogeneity is a significant obstacle to providing children with cerebral palsy with efficient services. Children with CP can have a wide range of clinical presentations, from those who can walk and handle objects on their own to those who have severe mobility and manual ability limitations made worse by coexisting medical conditions like epilepsy and cognitive issues (3). As a result, grouping kids with cerebral palsy into more uniform groups according to their functional profiles is helpful. It is anticipated that the adoption of functional profiles in clinical settings will yield a thorough description of the skills of children with CP, potentially leading to better research and service planning. Functional classifications like the Manual Ability Classification System (MACS) (4) and the Gross Motor Function Classification System-Expanded and Revised (GMFCS-E & R) (5) can be used to characterize the functional profiles of CP children. In health care systems, functional categories help plan services and establish functional goals for children with cerebral palsy (6).

It is possible to describe the functional profiles of children with CP by associations between the GMFCS-E & R and the MACS (7, 8). Based on their present gross motor function performance, CP children are

categorized into five levels using the first activity-based classification system, the GMFCS-E & R. Later, the MACS was created to categorize CP children based on their manual skills. For the classification of children with CP, both classifications showed satisfactory validity and reliability (9). The functional profiles of CP children are well defined between the GMFCS-E & R and the MACS, which represent different but complementary motor functions (10). Despite being accessible in Pakistan, neither the MACS nor the GMFCS-E & R is being utilized in any clinical settings there. Instead of using the functional categories, health workers are used to using the conventional impairment-based classification of cerebral palsy. As a result, rather than increasing children's activity and participation, rehabilitation treatments for kids with cerebral palsy concentrate on curing deficiencies. Thus, using functional profiles could offer a framework for categorizing CP children according to their function levels and directing rehabilitation efforts in Pakistan toward results that are significant to CP children and their families. This study, as far as we are aware, is the first in our nation to describe the functional profiles of CP children using the GMFCS-E & R and MACS. It is anticipated that functional profiles will cause rehabilitation in Pakistan to move away from impairment-based therapies and toward function-based ones. Functional profiles can also be used to direct service planning and distribute scarce resources to regions where children with cerebral palsy have the greatest needs.

METHODOLOGY

The study had a cross-sectional design. The study was carried out at the Pediatric Department of Liaquat University of Medical and Health Sciences, Jamshoro, for a duration of 6 months, i.e., from

February/2025 to May/2025. The study enrolled 102 children with cerebral palsy. The sample size was calculated by using the OpenEPI calculator by taking the prevalence of CP in MACS level-IV, i.e., 5.7%7, margin of error as 4.5%, confidence interval as 95%, then at least a sample of 102 patients of CP was required. A non-probability consecutive sampling technique was used.

The study included children aged 2 to 12 years with CP and both genders.

Patients with hydrocephalus (it was diagnosed on MRI scans showing enlarged ventricles caused by excess cerebrospinal fluid) and neurodegenerative patients (identified by MRI, which revealed a degenerative process that either showed the atrophy of particular regions or the degradation of specific structures).

Cerebral Palsy was diagnosed based on these signs and symptoms, i.e., developmental delay, such as the child being unable to walk/ sit, or hold things by 2 years of age, abnormal muscle tone, like stiff/floppy hands and feet, and abnormal posture, such as being unable to stand/sit straight. The functional profile of CP children was based on the GMFCS-E & R and MACS. When the patient was presented standing in a hospital gown, their height (in centimeters) and weight (in kilograms) were measured using a wall-mounted scale and an electronic weighing device, respectively. Comorbid conditions were assessed clinically. A child was diagnosed with hearing problems if they were unable to hear sound (as determined by a bell), spoke incoherently or with limited vocabulary, or did not pay attention or follow instructions. Vision Problems were considered positive if a child had hand-eye coordination difficulties, red, watery, or irritated eyes, and frequent squinting or rubbing eyes. Speech Disorders were deemed as positive by observing in the child slurred speech, mumble, speak too slowly or too quickly, or have soft or quiet speech, and/or the child might not say certain sounds correctly, such as p, b, m, h, and w. Seizure was labelled as positive by the presence of at least three of these signs and symptoms, i.e., jerking movements, color change of the lips or face, stiffening of the body, eyes, or head turned into one direction, not responding to noise or words, and appearing confused. All patients presenting in the OPD of the Pediatric department of LUMS fulfilling our eligibility criteria were included in this study. The participants' parents or guardians provided written informed consent. Demographic details, which included age, height, weight, BMI, gender, household income, educational status of parents, occupation of parents, ethnicity, co-morbidities, and conditions and types of CP, were noted and recorded on the approved performa. The functional profile of all the participants was assessed using GMFCS-E & R and MACS. The researcher herself did the entire procedure, and the findings were subjected to statistical analysis.

Data was entered and analyzed by using SPSS version 21.0. The Shapiro-Wilk test was applied to check the normality of quantitative data, and as the data were non-normal in distribution, variables like age, height, weight, and BMI were presented as median and interquartile range (IQR). Frequencies and percentages were for categorical variables like gender, monthly household income, educational status of parents, occupation of parents, co-morbidities, and functional profile of the CP using GMFCS-E & R and MACS. Due to the ordinal nature of the variables, Spearman's Rho correlation coefficient (rs) was computed. The following standards were applied in the interpretation of Spearman's Rho coefficient (rs): Relationships with rs >0.8 were powerful; those with rs 0.6 to <0.8 were strong; those with rs >0.4 to <0.6 were moderate; those with rs >0.2 to <0.4 were weak; and those with rs <0.2 were very weak.

RESULTS

A total of 138 patients were enrolled. The median (IQR) age of the patients was 6 (4) years. The median (IQR) weight was 66 (29.15) pounds, height was 3.4 (0.9) feet, and BMI was 18.6 (5.99) lbs/in2

(Table I).

There were 52 (51%) males and 50 (49%) females in the study. The monthly income of the parents was <20,000 rupees in 17 (16.7%) patients, between 20,000 and 50,000 rupees in 58 (56.9%) patients, and 27 (26.5%) patients had a monthly income of >50,000 rupees. In terms of educational status of the parents, 19 (18.6%) patients' parents were illiterate, 34 (33.3%) patients' parents have done matric, 20 (19.6%) patients' parents had education till secondary, 18 (17.6%) patients' parents have done matric and 11 (10.8%) patients' parents have above graduation status. With respect to occupation of the parents, 30 (29.4%) parents had a private job, 29 (28.4%) parents had a government job, 36 (35.3%) were self-employed, and 7 (6.9%) parents were students. In terms of comorbidities, there were no comorbidities in 61 (59.8%) children, hearing problems were present in 12 (11.8%) patients, vision problems were present in 11 (10.8%) patients, speech deficit was present in 10 (9.8%) patients, and seizures were reported by 8 (7.8%) patients (Table II).

According to GMFCS-E&R, 17 (16.7%) patients were classified to be on level I, level II was seen in 27 (26.5%) patients, level III was present in 24 (23.5%) patients, impairment of level IV was present in 28 (27.5%) patients and of level V was present in 6 (5.8%) patients and according to MACS, 25 (24.5%) patients were classified at being on level I, level II was seen in 44 (43.2%) patients, level III impairment was present in 15 (14.7%) patients, level IV impairment was present in 14 (13.7%) patients and level V impairment was seen in 4 (3.9%) patients and there was significant strong correlation between both classification system as indicated by an rs value of 0.623 and p value of <0.001 (Table-III).

Table 1: Median (IQR) of Quantitative Variables (n=102)

Variables	Median (IQR)
Age (in years)	6 (4)
Weight (in pounds)	66 (29.15)
Height (inches)	39.5 (9)
BMI (lbs/inches ²)	18.6 (5.99)

Table 2: Frequency of baseline demographic and clinical characteristics (n=102)

Variables	Frequency (percentage)
Gender	
Male	52 (51%)
Female	50 (49%)
Monthly household income	
<20,000	17 (16.7%)
20000-50000	58 (56.9%)
>50000	27 (26.5%)
Educational status of parents	
Illiterate	19 (18.6%)
Matric	34 (33.3%)
Secondary	20 (19.6%)
Graduate	18 (17.6%)
Above graduate	11 (10.8%)
Occupation of parents	
Private job	30 (29.4%)
Government job	29 (28.4%)
Self-employed	36 (35.3%)
Student	7 (6.9%)
Comorbidities	
None	61 (59.8%)
Hearing problem	12 (11.8%)
Vision problem	11 (10.8%)
Speech deficit	10 (9.8%)
Seizure	8 (7.8%)

Table 3: Frequency of gross and functional motor impairment and correlation between GMFCS-E & R and MACS (n=102)

Level	GMFCS-E&R	MACS	rs Value	p VALUE
I	17 (16.7%)	25 (24.5%)	0.623	<0.001
II	27 (26.5%)	44 (43.2%)		
III	24 (23.5%)	15 (14.7%)		
IV	28 (27.5%)	14 (13.7%)		
V	6 (5.8%)	4 (3.9%)		

DISCUSSION

The current study findings revealed that in patients with cerebral palsy, according to both GMFCS-E&R and MACS, the majority of the children had gross and functional motor impairment between levels II and IV, and there was a significantly strong correlation ($p<0.001$) between GMFCS-E&R and MACS for grading gross and functional motor impairment. The majority of the participants in the study group were male, with the monthly income of the parents being between >20,000 and 50,000 rupees. The parents were mostly matriculate, and their occupation was self-employed. The commonest comorbid condition in the participants was a hearing problem.

The most prevalent physical disability in children is cerebral palsy (CP) (11). CP is a diverse collection of conditions that can lead to muscle contractures, weakness, spasticity, dystonia, and coordination issues, all of which can impair one's capacity to govern movement (12). In the past, the motor type, topographical distribution, and subjective severity level have all been used to categorize cerebral palsy (13). These kinds of vague phrases might hinder clear communication between providers and reveal very little about a person's functioning abilities (14). More recently, a straightforward ordinal grading system for functional performance has been used to develop classification systems (15). Better subject classification for research and more accurate provider-to-provider discussions are made possible by these technologies (16, 9). However, little is known about these classification systems in Pakistan. Keeping this in view, the current study was carried out to compare the level of gross and functional motor impairments in children with CP according to GMFCS-E&R and MACS, and also to assess the correlation between these two classification systems.

Our study findings revealed that according to GMFCS-E&R, 17 (16.7%) patients were labeled at level I, impairment of level II was seen in 27 (26.5%) patients, of level III was present in 24 (23.5%) patients, of level IV was present in 28 (27.5%) patients and of level V was present in 6 (5.8%) patients. According to MACS, level I category was present in 25 (24.5%) patients, level II was seen in 44 (43.2%) patients, level III impairment was present in 15 (14.7%) patients, level IV impairment was present in 14 (13.7%) patients, and level V impairment was seen in 4 (3.9%) patients. Almasri *et al.* carried out a study to describe functional profiles of children with CP based on the GMFCS-E & R and the MACS. They revealed that as per GMFCS-E & R classification, 16 (13.1%) were classified in Level-I, 28 (23%) in level-II, 15 (12.3%) in level-III, 41 (33.6%) in level-IV, and 22 (18%) in level-V and as per MACS classification, 37 (30.3%) were classified in Level-I, 41 (33.6%) in level-II, 17 (13.9%) in level-III, 7 (5.7%) in level-IV, and 20 (16.4%) in level-V (7). Himmelman *et al.* revealed that according to GMFCS-E&R, 32% of GMFCS were allocated at Level I, 29% at Level II, 8% at Level III, 15% at Level IV, and 16% at Level V (17). According to Mutlu *et al.*, children were classified as having GMFCS-E&R Level I impairment in 9 (3%) patients, level II impairment in 59 (18%) patients, level III impairment in 58 (17.7%) patients, level IV impairment in 101 (30.9%) patients and level V impairment in 100 (30.6%) patients and according to MACS, level I impairment was seen in 93 (28%) patients, level III impairment was present in 65 (20%) patients, level IV impairment occurred in 80

(25%) patients and level V impairment was reported in 39 (12%) patients (18). Thus, according to the current study and those conducted previously, it has been found that children with CP have mainly gross and functional motor impairment of level II to level IV.

The results of our investigation revealed a strong and significant correlation between the two classification systems, as indicated by $rs=0.63$ ($p<0.001$). Almasri *et al.*'s study showed a substantial relationship between MACS levels and GMFCS-E & R ($rs: 0.73$, $p<0.001$)⁷. Compagnone *et al.* similarly found that the functional profile assessed by GMFCS-E&R and MACS had a strong correlation ($rs=0.67$, $p=0.001$) (19). These studies are consistent with our study results. Children with CP frequently experience sensorimotor and developmental issues that impact their everyday life activities, including problems with mobility, manual skills, and communication. To categorize the gross motor, manual ability, and communication function performances of children with cerebral palsy, clinicians and researchers can employ GMFCS-E&R and MACS classification systems. Additionally, families can use the same procedures as specialists to accurately classify their children, allowing for the realistic measurement of these children..

CONCLUSION

The current study concluded that CP children, both GMFCS-E&R and MACS, reported that Level II to IV gross and functional motor impairment was frequently encountered, and there was a significantly strong correlation between these two classification systems. For clinical and research-oriented pediatric rehabilitation, the GMFCS-E&R and MACS can often be used to categorize the different functions and performances of children with CP in an easy-to-use and affordable way. To validate the results of the current study, larger samples must be used in future research.

DECLARATIONS

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned.

Consent for publication

Approved

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

RACHANA (POST-GRADUATION)

Conceived the study, collected data, performed initial analysis, and prepared the first draft of the manuscript

ABDUL HAMEED RADHAN (ASSOCIATE PROFESSOR)

Supervised the research, provided expert guidance, and critically reviewed the manuscript

ZAMIR AHMED QAMBRANI (ASSISTANT PROFESSOR)

Contributed to methodology design, data interpretation, and manuscript editing

KHUDA BUX KHOSO (ASSISTANT PROFESSOR)

Assisted in statistical analysis, data validation, and final approval of the manuscript

FARZANA SHAIKH (PROFESSOR)

Provided overall supervision, expert insight, and final critical review of the manuscript

SHAHZAD AHMED (SENIOR REGISTRAR)

Helped in data collection, organization of findings, and manuscript formatting

All authors read and approved the final version of the manuscript.

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