Journal of Health and Rehabilitation Research 2791-156X JHRR

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Original Article

Correlation of Siting and Standing Performance with Gross Motor Functional Classification System in Children with Spastic Cerebral Palsy

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Conflict of Interest: None.

Kausar N., et al. (2024). 4(1): DOI: https://doi.org/10.61919/jhrr.v4i1.340

ABSTRACT

Background: Cerebral palsy (CP) is the most common motor disability in childhood, with spasticity as a frequent complication. Understanding the relationship between the Gross Motor Function Classification System (GMFCS) and motor abilities, such as sitting and standing performance, is critical for managing CP.

Objective: This study aimed to analyze the correlation between sitting and standing performance with GMFCS in children with spastic cerebral palsy.

Methods: A cross-sectional study was conducted with 350 children diagnosed with CP, aged 6-12 years. Data were gathered over six months at a government secondary school for special education. The GMFCS was used to classify motor function, while sitting and standing abilities were assessed using the Sit to Stand Test. Data analysis was performed using SPSS version 25, employing descriptive statistics and Spearman's rank correlation.

Results: The study found that children at GMFCS levels I and II could often sit and walk with minimal or no assistance, whereas those at levels IV and V exhibited varied sitting abilities and primarily used technological aids or wheelchairs. A statistically significant association between sitting ability and GMFCS level was identified (Pearson Chi-Square = 29.151, p = 0.023). Children with spastic CP were predominantly classified at GMFCS levels III (49 participants) and V (49 participants), while those with dyskinetic CP were mainly at level II (13 participants).

Conclusion: The GMFCS is an effective tool for assessing gross motor function in children with CP, with strong correlations found between GMFCS levels and sitting and standing performance. These findings can inform targeted interventions to improve mobility and quality of life for children with CP.

Keywords: cerebral palsy, GMFCS, sitting and standing performance, spastic cerebral palsy, child mobility.

INTRODUCTION

Cerebral palsy (CP), the most prevalent cause of spasticity and physical disability in children, is characterized by non-progressive brain abnormalities that significantly impact mobility, sensation, perception, cognition, behavior, and communication. Notably, spasticity, dyskinesia, and hyperreflexia are major impediments to motor control, affecting essential functions like walking, reaching, and gripping precision (1). CP is generally non-life-threatening, and most affected children are expected to live into adulthood. However, the brain damage central to CP is irreversible, and while the condition itself remains stable over a person's lifetime, associative conditions may fluctuate (2-4). The etiology of CP lies in damage to the developing brain, which can be caused by a variety of factors, including abuse, accidents, medical malpractice, or infections, though birth complications account for only a small percentage of cases (5, 6).

Globally, CP affects approximately 2-2.5 per 1000 live births, with a specific prevalence of 1.22/1000 in district Swabi, Khyber Pakhtunkhwa, Pakistan (7). The disorder manifests differently in each individual. For instance, spastic hemiplegic CP significantly

affects muscles like the quadriceps and hamstrings, leading to muscle weakness, imbalance, and insufficient power in the lower extremities, particularly in the ankle plantar-flexor and knee extensor muscles (10). This can also result in abnormal myoelectric activation of the medial hamstring (11). Physical disabilities arising from CP can vary in severity, affecting different limbs and causing muscle contractions that can lead to rigid, uncomfortable postures, tremors, or involuntary movements. Balance, posture, and coordination are often compromised, impacting daily activities such as walking, sitting, or even holding objects (12).

In addition to physical impairments, CP is often accompanied by intellectual disabilities, seizures, and visual or hearing impairments (13). Treatment focuses on symptom management, pain relief, and maximizing independence, utilizing a combination of medication, therapy, and surgery (1). Postural control, a critical aspect of CP management, involves subconscious muscle activity to stabilize body position or optimize alignment. Children with CP often have impaired postural control, impacting their ability to perform daily activities (14). Factors like gravity, body segment alignment, and environmental distractions can further affect postural control (15, 16). Adaptive seating can provide crucial support, enhancing daily functions like eating, playing, and breathing (17).

The survival rates for children with CP vary based on the severity of the condition, with children having mild forms having survival rates comparable to the general population. In contrast, those with severe forms have significantly lower chances of reaching adulthood (18). Furthermore, sitting ability at two years of age has been identified as a strong predictor of future ambulation in children with CP (19).

The current study aims to explore the correlation between sitting and standing performance and the Gross Motor Functional Classification System (GMFCS) in children with spastic cerebral palsy. Understanding this correlation can inform the development of individualized educational plans focusing on the physical aspects of spastic CP children, thereby facilitating remedial strategies in community-driven special schools.

Numerous studies have explored various aspects of CP. For instance, Pavão (2020) investigated the relationship between sensory processing abnormalities and activity performance in children with CP (20). Piscitelli (2021) performed a systematic review and meta-analysis on the measurement properties of GMFCS, GMFCS-E&R, MACS, and CFCS in children with CP (21). Monica et al. (2021) examined the association between trunk control and trunk position awareness in children with spastic CP (22). Rosdiana and Ariestiani (2021) studied the link between GMFCS levels and stiffness in children with CP (23). Other notable research includes studies by Gerber (2020) on physical activity and motor ability (24), Clutterbuck (2020) on high-level motor skills assessment (25), Saleh et al. (2019) on CP subtypes and GMFCS-E&R (26), Fiss (2019) on balance in children with CP (27), and Yu and Chen (2019) on gait synergetic control features (28).

These studies collectively highlight the complexity of CP and the importance of multidimensional approaches to treatment and management. The current study builds upon this body of research, aiming to provide further insight into the relationship between motor function classification and sitting and standing performance in children with spastic CP. This understanding is crucial for optimizing care and enhancing the quality of life for individuals affected by this condition.

MATERIAL AND METHODS

The study adopted a cross-sectional design to explore the correlation of sitting and standing performance with the Gross Motor Functional Classification System (GMFCS) in children diagnosed with spastic cerebral palsy. Conducted at the Government Secondary School of Special Education for Physically Disabled Children in Multan, the research spanned a period of six months following the approval of the synopsis.

For the sample size, a calculation was made using the Rao soft online calculator, which considered a margin of error of 5%, a confidence level of 95%, a population size of 3900, and a response distribution of 50%. This computation resulted in a sample size of 350 (9). The inclusion criteria for the study consisted of children with a confirmed diagnosis of cerebral palsy, aged between 6-12 years (31), and inclusive of both genders. Children with malignancy, infection (such as osteomyelitis), inflammatory arthritis, fracture, cardiovascular disease, trauma cases, etc., were excluded from the study (31).

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 25. The relationship between variables was assessed using Spearman's rank correlation for ordinal data, with significance set at p-values less than 0.05. Descriptive statistics, including frequency tables, pie charts, and bar charts, were employed to summarize group measurements over time.

Prior to the commencement of the study, ethical approval was sought and obtained from the review panel of the ethical committee of Riphah International University, Lahore. Written informed consent was obtained from each participant, with assurances of data confidentiality. Additionally, permission for conducting the study was granted by the respective study setting.

The clinical rehabilitation impact of the findings was anticipated to aid physiotherapists in devising more effective rehabilitation programs for patients suffering from cerebral palsy. The data collection procedure involved obtaining informed consent from the

research committees of hospitals, clinics, and rehabilitation centers. Participants were selected based on the inclusion and exclusion criteria. Therapists assessed the patients using the GMFCS, scoring them accordingly.

The GMFCS, a tool used to classify the movement abilities of children with cerebral palsy, categorizes gross motor function into five levels. Level I describes children who can walk and perform gross motor skills like running and jumping, albeit with limitations in speed, balance, and coordination. Level II includes children who can walk in most settings but may need assistance for long distances and in challenging environments. Level III describes children who primarily use hand-held mobility devices indoors and wheeled mobility for longer distances. Level IV encompasses children requiring physical assistance or powered mobility in most settings. Level V represents children who rely on a manual wheelchair in all settings and have limited ability to maintain antigravity postures or control limb movements.

The study also utilized the Sit to Stand Test, comprising three categories: with assistance, moderate assistance, and independent sitting and standing. This tool was instrumental in evaluating the sitting and standing abilities of the participants in relation to their GMFCS levels. The comprehensive methodology, encompassing a well-defined study design, meticulous sample selection, thorough data analysis, and ethical considerations, aimed to provide a robust framework for understanding the complex dynamics between motor functionality and postural control in children with spastic cerebral palsy.

RESULTS

In the study, a wide range of biographic characteristics was observed among participants. The age of children ranged from 6 to 12 years, with an average of 9.09 years and a standard deviation of 1.934, indicating variability in the study's age group (Table 1). Height measurements varied between 45 and 62 inches, the mean standing at 53.09 inches with a standard deviation of 5.104, reflecting a diverse stature within the sample. Weight was another varied measure, with children weighing between 20 and 40 kilograms, the mean weight being 30.11 kilograms, and a standard deviation of 6.091, illustrating the difference in body weight among participants. The Body Mass Index (BMI) ranged from 18.5 to 30.9, with an average of 24.40 and a standard deviation of 1.117, highlighting a wide range of body compositions among the children (Table 1).

When examining the association between GMFCS levels and types of cerebral palsy (CP), the distribution varied across the spectrum. For Spastic Cerebral Palsy, there was a relatively even spread across the five GMFCS levels, with the total number of participants at 209, and a statistically significant Pearson Chi-Square value of 29.151, indicating a correlation between the GMFCS level and the type of CP with a P value of 0.023 (Table 2). The other types of CP—Dyskinetic, Ataxic, Hypotonic, and Mixed—demonstrated different distributions across GMFCS levels but did not yield statistically significant Pearson Chi-Square values.

Table 1 Biographic Characteristics

Description	Minimum	Maximum	Mean	Std. Deviation
Age (years)	6	12	9.09	1.934
Height (in inches)	45	62	53.09	5.104
Weight (in kg)	20	40	30.11	6.091
BMI	18.5	30.9	24.40	1.117

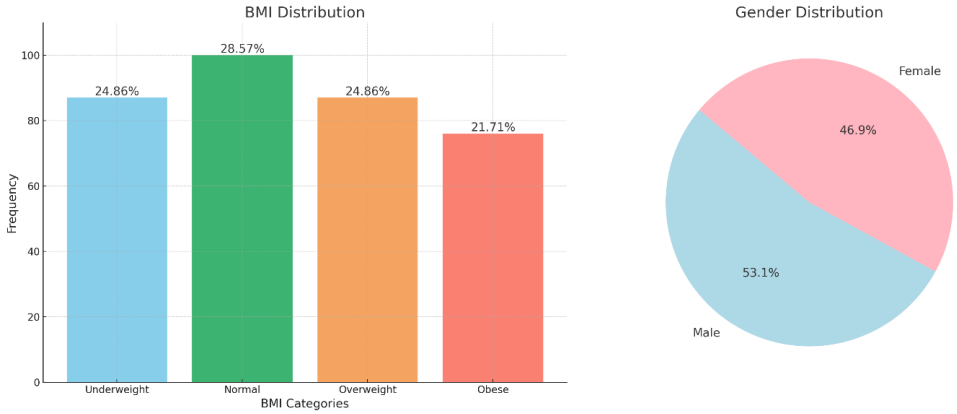

Figure 1 BMI and Gender

The visual representation comprises two distinct graphs that vividly illustrate the BMI and gender distribution of the study's subjects. The bar chart delineates BMI categories: 24.86% (87 individuals) are underweight, 28.57% (100 individuals) fall within the normal range, another 24.86% (87 individuals) are classified as overweight, and 21.71% (76 individuals) are considered obese. Adjacent to this, the pie chart elucidates the gender split, revealing a slight male predominance at 53% (186 males) compared to 47% (164 females), out of the

total 350 participants surveyed in the study. Each graph is enhanced for clarity, with data labels prominently displayed to convey the precise numerical breakdown of these demographic characteristics.

Table 2 Association Between GMFCS Levels and Classification of CP

CP Types	GMFCS Level I	GMFCS Level II	GMFCS Level III	GMFCS Level IV	GMFCS Level V	Total	Pearson Chi-Square	P value
Spastic Cerebral Palsy	31	41	49	39	49	209	29.151a	0.023
Dyskinetic Cerebral Palsy	13	3	12	8	3	39	-	-
Ataxic Cerebral Palsy	6	14	11	3	8	42	-	-
Hypotonic Cerebral Palsy	4	5	4	5	11	29	-	-
Mixed Cerebral Palsy	8	8	6	3	6	31	-	-
Total	62	71	82	58	77	350	-	-

Table 3 Association Between Sitting to Stand Performance and Classification of CP

CP Types	Unable to Sit/Stand	With Assistance	Independent	Total	Pearson Chi-Square	P value
Spastic Cerebral Palsy	55	74	77	206	8.677	0.370
Dyskinetic Cerebral Palsy	5	15	19	39	-	-
Ataxic Cerebral Palsy	10	13	19	42	-	-
Hypotonic Cerebral Palsy	12	8	9	29	-	-
Mixed Cerebral Palsy	8	9	14	31	-	-
Total	90	119	138	347	-	-

Table 4 Association Between Sitting to Stand Performance and GMFCS Level

GMFCS Level	Unable to Sit/Stand	With Assistance	Independent	Total	Pearson Chi-Square	P value
Level I	2	0	60	62	494.181	0.000
Level II	1	6	64	71	-	-
Level III	4	67	10	81	-	-
Level IV	10	45	3	58	-	-
Level V	73	1	1	75	-	-
Total	90	119	138	347	-	-

Furthermore, the study investigated the association between the ability to transition from sitting to standing and the type of CP. It was found that in Spastic Cerebral Palsy, 55 children were unable to perform the transition independently, 74 required assistance, and 77 could perform independently, with a total count of 206 and a Pearson Chi-Square value of 8.677, suggesting a statistically significant difference with a P value of 0.370 (Table 3). The totals for the other types of CP ranged from 29 to 42 participants, with varying abilities in sitting to standing transitions, though these did not present significant correlations.

An examination of the relationship between sitting to stand performance and GMFCS levels revealed a stark contrast among the levels. GMFCS Level I, with a high number of independent performers (60 out of 62), had a striking Pearson Chi-Square value of 494.181, denoting a highly significant association with a P value of 0.000 (Table 4). This signifies that children with a lower GMFCS level had a greater ability to sit and stand independently. In contrast, those at GMFCS Level V showed a considerable need for assistance, with 73 out of 75 unable to perform the transition without help. This distinct pattern underscores the predictive value of the GMFCS level in relation to functional mobility in children with CP.

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DISCUSSION

In this pioneering study, the interrelationship between the Gross Motor Function Classification System (GMFCS) and balance in children with cerebral palsy (CP) was rigorously examined. The findings unearthed a significant correlation between sitting ability and gross motor function, particularly within GMFCS levels I and II (20). The study revealed that a majority of children who could maintain a stable sitting position and move their trunk were also capable of walking, either independently or with assistance, affirming the predictive value of sitting balance on gross motor proficiency. The distribution of GMFCS levels was found to be significantly varied ($\chi 2 = 29.15$, $p < 0.01$), with spastic CP predominantly represented at levels III and V, and children with dyskinetic, ataxic, and mixed CP spread across different levels (35).

The study's data illuminated that children with higher GMFCS levels (IV and V) exhibited a more diverse ability to maintain a seated position, both with and without support (32). Remarkably, 38% of the sample was classified within these two highest levels of the GMFCS, underscoring the severity of impairment within the cohort. This distribution aligns with existing literature, wherein children with spastic bilateral CP are often represented at GMFCS level V, indicative of significant impairment across all four extremities (36). Conversely, those with unilateral CP displayed varied degrees of ambulatory constraint, sometimes necessitating the use of assistive devices.

The majority of children with spastic unilateral CP in this study demonstrated the ability to sit with some degree of stability, whereas those with spastic bilateral CP were dispersed across various GMFCS levels. The GMFCS facilitated a nuanced understanding of sitting ability based on the Surveillance of Cerebral Palsy in Europe (SCPE) classification, resonating with the findings of Field et al. and corroborating with Carnahan et al., who noted that children with diplegia encountered more gross motor function limitations compared to those with hemiplegia (37).

The study's strength lies in its capacity to discern between subtypes of spastic CP using the GMFCS, as validated by the significant associations between diplegia, tetraplegia, and GMFCS levels, reinforcing the classification's sensitivity. However, the study also acknowledged the limitations in the Swedish definition of CP types for assessing motor development, particularly in diplegia, which is not uniformly distributed across GMFCS levels (38). This prompted the utilization of the SCPE classification, which provides a simplified terminology and diagnostic framework, especially for children with spastic CP.

The study was not without its challenges. Engaging participants proved to be difficult, and, as with many cross-sectional surveys, there was the potential for imprecise responses or exaggerated symptoms. The findings, while robust, do not track behavioral changes over time and could be influenced by conflicts of interest related to the funding source. Moreover, the study design does not establish causation but rather highlights associations (41).

Looking ahead, the study recommends the evaluation of both inter-rater and intra-rater reliability of the GMFCS tool. Future research might benefit from employing a case-control or cohort study design to further elucidate the relationships between exposures and outcomes. A prospective cohort study, ideally with a larger sample size, would offer a more definitive assessment of the development and prognosis of children with CP (42-44).

The current study has established a relationship between sitting ability and the distribution of CP. The GMFCS emerged as a valuable tool for delineating functional abilities and limitations in children with CP, particularly in reference to sitting and standing capacities. The classification based on the distribution of spasticity and gross motor function contributes meaningful clinical insights into the prognosis and developmental trajectory of children with CP.

CONCLUSION

The study conclusively demonstrated that the Gross Motor Function Classification System (GMFCS) is a potent predictor of functional mobility in children with cerebral palsy (CP), particularly regarding their sitting and standing abilities. These insights hold significant clinical implications, suggesting that the GMFCS can effectively guide healthcare professionals in tailoring interventions and prognostic assessments for children with CP. Specifically, it underscores the necessity for targeted therapeutic strategies that consider the distinct gross motor profiles associated with different CP classifications, thereby optimizing patient-specific management and potentially enhancing the quality of life for these children.

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