Research Article

COMPARISON OF FUNCTIONAL WALKING, BALANCE AND FUNCTIONAL INDEPENDENCE IN CHILDREN WITH DIPLEGIC AND HEMIPLEGIC CEREBRAL PALSY

Kamal AL-AAYEDI[1], Anıl ÖZÜDOĞRU[2]

ABSTRACT

Purpose: Cerebral palsy results in brain damage to specific regions responsible for regulating muscle tone, gross and fine motor skills, balance control, and posture. This condition directly impacts patients' ability to walk, maintain balance, and perform everyday tasks effectively. The objective of this study was to compare the functional walking ability, balance, and functional independence of children with hemiplegic and diplegic cerebral palsy.

Methods: A study employing a cross-sectional observational design was done in three hospitals in Wasit province, Iraq, with a sample of 60 children diagnosed with cerebral palsy. The demographic information of 30 patients diagnosed with diplegia and 30 patients diagnosed with hemiplegia, aged between 0 and 18 years, and classified as level I-III in the Gross Motor Classification System (GMFCS), was documented. The patients underwent assessment using the Gillette Functional Gait Assessment Questionnaire (FAQ), the Pediatric Balance Scale (PBS), and the Independence Measure for Children (WeeFIM).

Results: The statistical analysis revealed a significant difference between the groups in FAQ and PBS ($p<0.05$). Considering the WeeFIM scores, except for locomotion and sphincter control parameters, no significant difference was found in other WeeFIM sub-scores between the groups ($p > 0.05$).

Conclusion: Children with hemiplegia have significantly better walking, balance, and lower extremity function than children with diplegia. However, they have worse upper-extremity performance. Based on the results of the study, the researchers suggest developing physiotherapy interventions or modalities adapted to the kind of CP and limitations experienced by people with CP to improve their ability to do functional activities with greater independence.

Keywords: Balance, Cerebral palsy, Gait, Independence.

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[1] Corresponding Author: Kırsehir Ahi Evran University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, Kırsehir, Turkey kamalalaidi37@gmail.com ORCİD: 0000-0002-6603-1382

[2] Assist Prof. Dr, Kırşehir Ahi Evran University, School of Physical Therapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, Kırşehir, Turkey aozudogru@ahievran.edu.tr ORCİD: 0000-0002-7507-9863

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Diplegik ve Hemiplejik Serebral Palsili Çocuklarda Fonksiyonel Yürüyüş, Denge ve Fonksiyonel Bağımsızlığın Karşılaştırılması

Öz

Amaç: Serebral palsi; kas tonusu, kaba ve ince motor beceriler, denge ve postürün düzenlenmesinden sorumlu belirli bölgelerinde meydana gelen beyin hasarı sonucu oluşur. Bu durum hastaların yürüme, dengeyi koruma ve günlük hareketleri etkili bir şekilde yerine getirme yeteneğini etkiler. Bu çalışmanın amacı hemiplejik ve diplejik serebral palsili çocukların fonksiyonel yürüme yeteneği, denge ve fonksiyonel bağımsızlığını karşılaştırmaktır.

Yöntem: Irak'ın Wasit eyaletindeki üç hastanede serebral palsi tanısı alan 60 çocuktan oluşan bir örneklemle kesitsel bir çalışma yapıldı. Yaşları 0-18 arasında olan ve Kaba Motor Fonksiyon Sınıflandırma Sistemine (KMFSS) göre seviye I-III olarak sınıflandırılan dipleji tanısı alan 30 hastanın ve hemipleji tanısı alan 30 hastanın demografik bilgileri kaydedildi. Hastalara Gillette Fonksiyonel Yürüyüş Değerlendirme Anketi (Gillette-FYDA), Pediatrik Denge Ölçeği (PDÖ) ve Pediatrik Fonksiyonel Bağımsızlık Ölçeği (WeeFIM) kullanılarak değerlendirme yapıldı.

Bulgular: İstatistiksel analiz, Gillette Fonksiyonel Yürüyüş Değerlendirme Anketi ve Pediatrik Denge Ölçeğinde gruplar arasında anlamlı bir fark olduğunu ortaya çıkardı ($p<0.05$). WeeFIM skorlarına bakıldığında lokomosyon ve sfinkter kontrol parametreleri dışında diğer WeeFIM alt skorlarında gruplar arasında anlamlı fark bulunamadı ($p > 0,05$).

Sonuç: Hemiplejik çocukların yürüme, denge ve alt ekstremite fonksiyonları diplejili çocuklara göre anlamlı derecede daha iyidir. Ancak üst ekstremite performansları daha kötüdür. Araştırmanın sonuçlarına dayanarak, araştırmacılar SP'nin türüne ve SP'li bireylerin yaşadığı kısıtlamalara göre uyarlanmış fizyoterapi müdahaleleri veya yöntemlerinin geliştirilmesini ve böylece fonksiyonel aktiviteleri daha fazla bağımsızlıkla yapma yeteneklerini geliştirmeyi önermektedir.

Anahtar Kelimeler: Denge, Serebral palsi, Yürüme, Bağımsızlık.

1. INTRODUCTION

Cerebral palsy (CP) is defined as a group of permanent movement and posture development disorders that cause limitations of activity attributed to non-progressive disorders that have occurred in the developing brain of the infant or child, and it is the most common physical disability in childhood. Sensation, perception, cognition, communication, and behavior abnormalities are common in CP motor disorders, as are seizures and subsequent musculoskeletal problems (Rosenbaum, 2003). A lesion that develops during the prenatal, natal, or postnatal periods can result in cerebral palsy. According to European data, the average frequency of CP is 2.08 per 1000 live births; however, rates vary by country and within countries (Sadowska et al., 2020). Cerebral palsy is classified into many motor impairments based on their topography: monoplegia, hemiplegia, diplegia, triplegia, and quadriplegia (Rojas et al., 2013). The degree of motor disability, which varies depending on the type of cerebral palsy, has a significant impact on functional limitations (Novak et al., 2012).

Gait disorders are one of the most common limitations in individuals with CP, and they affect participation and self-perception. Gait is a complicated activity because it requires the coordination of the central neurological and musculoskeletal systems. Many abnormalities in these systems cause severe interference with gait, making participation in normal human activities difficult (Gage, 2004). Walking is necessary for daily activities and social participation, and it is often regarded as one of the most important activities in daily life.

Functional balance is an aspect of postural control that allows a child to conduct basic daily, social, and recreational activities independently at school, home, and in the community (Opheim et al., 2012). The inadequate postural control system impairs functional balance in children with CP. Previous research on balance indicated that children with CP have poorer static and dynamic balance reactions than normally developing children (Panibatla et al., 2017). These balance issues increase the possibility of falls, which further impairs the performance of activities of daily living (ADL), participation, and mobility in children with CP. The acquisition of more complicated motor abilities, as well as the production of coordinated motor activity, require the development of postural stability.

The authors argued that executing functional tasks rather than developing precise movement patterns should be the primary goal of rehabilitation (Gooden-Ledbetter et al., 2007). Assessing a patient's functional skills is an important step in the rehabilitation process. Several factors affect how functional independence develops in people with cerebral palsy (CP). Internal (coming directly from the degree and type of palsy) and external (effect of the external environment) elements can be used to classify the factors that influence functional independence in people with CP (Ostensjo et al.,2003). This disorder has a secondary or aggravating effect on the child's developing capacity to learn and perform daily tasks.

There are four topographic classifications for CP: diplegia, quadriplegia, hemiplegia, and monoplegia. A significant overlap exists in the impacted area. According to most studies, the most prevalent forms are diplegia (30%–40%), hemiplegia (20%–30%), and quadriplegia (10%–15%) (Trisnowiyanto and Andriani, 2020). To our knowledge, there are very few studies comparing functional gait, balance, and functional independence between diplegia and hemiplegia together in the same study. As a result, the objective of this study was to compare children with hemiplegia to children with diplegia at GMFCS levels I–III, using multiple validated outcome tools to assess functional walking, balance, and functional independence.

In this context, the research hypotheses were defined as follows:

H0: There is no significant difference between functional gait, balance, functional independence, and gross motor function in hemiplegic and diplegic cerebral palsy.

H1: Children with hemiplegic cerebral palsy have better functional gait, balance, functional independence, and gross motor function than children with diplegia.

2. METHOD

A cross-sectional observational design was used in this study, which was carried out at three centers for children with cerebral palsy in Iraq's Wasit province. The Iraqi Ministry of Health's Research Ethics Committee/Wasit Health Directorate approved the study (approval date: July 13, 2021, and decision number: 172). An informed consent form was signed by the participants or their parents, and all procedures were carried out by the Helsinki Declaration.

2.1. Participants

Thirty participants in the current study had bilateral body side effects (diplegia), while thirty participants had unilateral body side effects (hemiplegia). All children with cerebral palsy have an abnormal gait, yet they can walk independently with or without walking aids. Participants' spasticity was identified and evaluated previously by a pediatric neurologist. The selection criteria included: diagnosis of CP by a specialist physician; mental level to understand the commands in the test parameters; child level I–III according to GMFCS; child age under 18 years old; and willingness to participate in the study provided by his or her family. Exclusion criteria included: a previous surgical intervention or Botox application in the last 6 months, as well as having resistant epilepsy, a serious systemic disease, or hearing or vision loss that could affect the assessment.

2.2. Assessment

Evaluation of Gross Motor Function: The gross motor functional classification system (GMFCS) for cerebral palsy is a five-level classification system based on self-initiated movement with a focus on sitting, transfers, and mobility, ranging from level I (most able) to level V (least able). Children in GMFCS levels I–III are referred to as 'ambulant,' whereas those in levels IV and V are referred to as 'non-ambulant.' (Palisano et al., 2008).

Functional Independence Assessment: The WeeFIM system is a 7-level ordinal measurement instrument with 18 items. WeeFIM is divided into two functional streams: "dependent" (needs assistance: scores 1–5) and "independent" (requires no helper: scores 6-7). Scores 1 (total assist) and 2 (maximal assist) fell under the category of "Complete Dependence." The "Modified Dependence" category had scores of 3 (moderate assistance), 4 (limited contact assistance), and 5 (surveillance or set-up). The "Independent" category had scores of 6 (limited independence) and 7 (complete independence) (Wong et al., 2002).

Gait Assessment: The Gillette Functional Gait Assessment Questionnaire (FAQ) was used in this study. The Gillette Functional Assessment Questionnaire (FAQ) is a self-or surrogate assessment that includes a ten-level ambulatory function categorization (FAQ Walking Scale) and 22 functional locomotor tasks scored on a five-level Likert difficulty scale (FAQ 22-item skill set). The scale has a minimum score of 22 and a maximum score of 88 (Gorton et al., 2011).

Balance Evaluation: The Pediatric Balance Scale (PBS) is a modified form of the Berg Balance Scale for assessing functional balance in children. The 14-item scale has a maximum score of 56 points, and values range from 0 (the lowest function) to 4 (the highest function). The researchers demonstrated how to perform each test before it was given to the patients. Unbalanced scores range from 0 to 20, acceptable balance ranges from 21 to 40, and good balance ranges from 41 to 56 points (Opheim et al., 2012).

2.3. Statistical Analysis

The sample size of the study was calculated as at least 26 individuals in a group, with a 95% confidence interval and 85% power, with the evaluation made in the G*Power (ver. 3.1.9.7) program based on the literature (Mutlu et al., 2017). The Statistical Package for Social Sciences (SPSS) version 22 was used for statistical analysis of the data. The Mann-Whitney U test was used to compare the quantitative data between two groups that did not show a normal distribution. The chi-square test was applied to examine the relationship between the two variables to understand whether there is a relationship between the two variables. The t-test was used to reveal the significance of the statistical differences between the means of two independent samples. Significance was evaluated at $p<0.01$ and $p<0.05$ levels.

3. RESULTS

The study was conducted with the participation of 60 children with CP who met the inclusion criteria. Table 1 shows the demographic information of the participants. According to the demographic data, 40 (66.5 %) of our participants were male (Table 1). In the diplegia group, the age range was (2.5–18), whereas in the hemiplegia group, the age range was (1.8–14). Gender and age data did not show a significant difference between the two groups ($p> 0.05$).

Table 1: Demographic Information of Participants

Demographic Category	Diplegia, n (%)	Hemiplegia, n (%)	Total, n (%)	P
Gender				0.580 †
Male	19 (63)	21 (70)	40 (66.50)	
Female	11 (37)	9 (30)	20 (33.50)	
Total, n (%)	30 (100)	30 (100)	60 (100)	
Age (years)	n = 30	n= 30	n= 60	0.601δ
Mean	7.10	7.10	7.10	
SD	4.30	3.40	3.85	
Range	2.50-18	1.80-14	1.80-18	
Birth Time				**0.010**** †
Premature	10 (33.33)	6 (20)	16 (26.67)	
Term	20 (66.67)	24 (80)	44 (73.33)	
Total, n (%)	30 (100)	30 (100)	60 (100)	
Assistive Device				**0.010**** †
Used	16 (53.33)	5 (16.67)	21 (35)	
Not used	14 (46.67)	25 (83.33)	39 (65)	
Total, n (%)	30 (100)	30 (100)	60 (100)	
Orthoses				0.090 †
Used	21(70)	13 (43.33)	34 (56.67)	
Not used	9 (30)	17 (56.67)	26 (43.33)	
Total, n (%)	30 (100)	30 (100)	60 (100)	
GMFCS Level				**0.020*** †
Level I	3 (10)	10 (33.33)	13 (21.67)	
Level II	14 (46.67)	15 (50)	29 (48.33)	
Level III	13 (43.33)	5 (16.67)	18 (30)	
Total, n (%)	30 (100)	30 (100)	60 (100)	

* p<0.05, ** p<0.01. † Chi-Square test for between-group comparison, δ Mann Whitney U test for between-group comparison, GMFCS: Gross motor functional classification system.

Table 2: Comparison of FAQ, WeeFIM, and PBS Between Diplegia and Hemiplegia Groups.

Demographic Category	Groups	Mean± SD	Min-Max (Median)	N	P
FAQ	Diplegia	42.40±12.15	22-70 (40)	30	**0.040***
	Hemiplegia	52.83±13.50	22-79 (54.55)	30	
WeeFIM	Diplegia	82.10±19.70	44-118(30.50)	30	0.320
	Hemiplegia	87.26±20.49	41-112(93)	30	
PBS	Diplegia	29.60±11.20	8-52(30.50)	30	**0.020***
	Hemiplegia	38.40±9.905	8-52 (40)	30	

* p<0.05. FAQ: Gillette Functional Gait Assessment Questionnaire, WeeFIM: The Functional Independence Measure for Pediatric, PBS: Pediatric Balance Scale.

When Table 2 is examined, it can be seen that there was a significant difference between groups in their FAQ scores (p< 0.05). Accordingly, the FAQ score of the hemiplegia group (mean = 52.83, SD±13.50) was higher than that of the diplegia group (mean = 42.4, SD±12.15). There was a significant difference (p = 0.02) between their PBS scores regarding their balance state. The PBS score of the hemiplegia group (Mean= 38.4, SD±9.905) was higher than that of the diplegia group (Mean= 29.6, SD±11.2). Table 2 shows that there was no statistically significant difference in their WeeFIM total scores in terms of functional independence (p = 0.32). However, the total WeeFIM scores in the diplegia group were lower than in the hemiplegia group. The WeeFIM subdomains did not differ statistically across groups (p > 0.05), except for a statistical difference between groups in the Sphincter control subdomain (p = 0.02; p< 0.05) and locomotion subdomain (p = 0.04; p< 0.05) (Table 3).

Table 3. Comparison of WeeFIM Results Between Groups Related to Subdomains

Demographic Data	Groups	Mean±SD	Min-Max (median)	N	P
Personal care	Diplegia	17,357±.7	33-6 (16)	30	0.49
	Hemiplegia	16.6±.7.0	26-6 (17)	30	
sphincter control	Diplegia	11.67±5.94	21-3 (13.5)	30	**0.02***
	Hemiplegia	14.9±.5.2	21-4 (16.5)	30	
Transfers	Diplegia	11.43±4.4	19-3 (11)	30	0.06
	Hemiplegia	13.66±.4.5	21-3(15)	30	
Locomotion	Diplegia	9.5±2.7	14-4 (9.5)	30	**0.04***
	Hemiplegia	10.86±.2.5	14-5 (12)	30	
Communication	Diplegia	13.1±1.6	14-6 (14)	30	0.06
	Hemiplegia	12.86±.1.5	14-10 (14)	30	
Cognitive	Diplegia	18.82±.4	21-13 (20)	30	0.4
	Hemiplegia	18.33±.2.3	21-13 (19)	30	

* p <0.05

In the diplegia group, 10 (33.3%) were born prematurely, whereas 20 (66.7%) were born on term. The hemiplegia group had a better outcome, with 6 (20%) being born prematurely and 24 (80%) being born at term. No one of our patients was born post-term. In terms of birth time, there was a significant difference between the two groups (p = 0.01). In our study, the utilization of assistive devices was recorded, and a large number of diplegia patients used assistive devices 16 (53.3 %). In contrast, 25 (83.3%) of patients with hemiplegia did not use an assistive device. The use of assistive devices differed significantly between the two groups (p = 0.01). Wearing orthoses is common among cerebral palsy patients; in our study, 21 (70%) of patients in the diplegia group had orthoses, whereas 13 (43.3%) of patients in the hemiplegia group had orthoses. All the patients included in the study had spastic CP. In the diplegia group, there were 3 (10%) GMFCS I patients, 14 (46.7%) GMFCS II patients, and 13 (43.3%) GMFCS III patients. In the hemiplegia, there were 10 (33.3%) GMFCS I patients, 15 (50%) GMFCS II patients, and 5 (16.7%) GMFCS III patients (Table 4).

Table 4. Comparison of GMFCS between diplegia and hemiplegia groups.

Demographic Data	Groups	Evaluation	N	%	Total	P
GMFCS Levels	Diplegia	Level I	3	10	30	**0.02***
		Level II	14	46.6		
		Level III	13	43.4		
	hemiplegia	Level I	10	33.3	30	
		Level II	15	50		
		Level III	5	16.7		

* p <0.05

4. DISCUSSION

The purpose of this study was to examine functional walking, balance, and functional independence in children up to 18 years old with diplegia and hemiplegia cerebral palsy in Iraq. According to our findings, significant differences were discovered between the two groups when the PBS was used to assess balance and the FAQ was used to assess functional walking. The total WeeFIM score used to assess functional independence did not differ significantly between groups. Only locomotion and sphincter control showed a significant difference in the WeeFIM subdomains. This result can be attributed to the difference between unilateral and bilateral lesions and the functional skills that can be performed with the upper or lower extremities at the same GMFCS level.

Males are more likely than females to have cerebral palsy and related developmental abnormalities, although the causes of this gap are unknown (Johnston and Hagberg, 2007). Based on the gender distribution in our study and literature studies, the male sex may be a risk factor for cerebral palsy (Chounti et al., 2013).

CP etiology has been linked to a variety of prenatal problems, with perinatal asphyxia accounting for less than 10%–20% of patients. Drougia et al. (2007) discovered that 79.5% of children diagnosed with CP were born prematurely in a 15-year review study (Drougia et al., 2007). In our study, 33.4% of individuals were born prematurely in the diplegia group, whereas 20% were born prematurely in the hemiplegia group.

Assistive devices are instruments that are used to help impaired people improve their physical functioning or eliminate the environmental barriers that hinder them from reaching their goals, thus improving their independence, participation options, and quality of life. In our study, 53.3% of diplegia participants utilized assistive devices, while in the hemiplegia group, 16.7% of participants required assistive devices. The high percentage of diplegia individuals who utilized assistive devices could be related to the fact that they had poorer gait function than the hemiplegia group. We think that this content's main focus should be on addressing the functional deficit that the mentioned tools have created.

The variation in functional independence among people with cerebral palsy (CP) allows us to investigate the various factors that influence independence development (Posłuszny et al., 2017). In the study of Damiano et al. (2006), they found the group with hemiplegia worse than the diplegia group in WeeFIM self-care and social cognition scores (Damiano et al., 2006). In another study, the hemiplegia group outperformed the diplegia group in the self-care, transfers, locomotion, and social cognition subgroups. In contrast, the diplegia group outperformed the hemiplegia group in the communication subgroup, and there was no difference in the sphincter control subgroup (Gunel et al., 2009). The disparity in the subgroup results can be related to the fact that the upper extremities were the most impacted, as well as the fact that a child's motivation and mental ability influence his ability to handle things and, consequently, their classification systems and functioning status.

The median total scores of PBS in diplegics were lower than those in spastic hemiplegics in a cross-sectional study that looked at the link between balance and trunk control (Panibatla et al., 2017). Our findings showed that hemiplegia patients had higher PBS total scores than diplegia patients, which is similar to previous studies. These results can be attributed to the high level of GMFCS in the hemiplegia group. There are some Basal muscle activity is another component that helps researchers understand the variations in standing balance between diplegic and hemiplegic individuals. Giralomi, Shiratori, and Aruin (2011) found that diplegic cerebral palsy patients had worse postural control than hemiplegic cerebral palsy patients. This was because their basal muscles (rectus femoris and biceps femoris) were more active before they moved (Girolami et al., 2011).

Ambulatory children with CP, the study's primary inclusion category, often fall into GMFCS Levels I–III. The majority of children with bilateral CP and substantially all children with unilateral motor disorders eventually ambulate at these levels; however, the initiation of walking may be delayed (Damiano et al., 2006). For children with cerebral palsy, independent walking is a crucial goal of rehabilitation. Despite these attempts, many children with cerebral palsy do not attain or sustain effective walking and will progressively depend on wheelchairs for most or all of their mobility requirements as they age (Gibson et al., 2012).

According to the researchers' knowledge of the literature reviews, few studies test functional walking skills using the FAQ in cerebral palsy patients without any intervention to differentiate between diplegia and hemiplegia cerebral palsy patients. Therefore, we assessed our participants' functional gait without any intervention using the Gillette Functional Assessment Questionnaire (FAQ). In most previous studies, hemiplegia outperformed diplegia in functional gait, which is consistent with our findings (Bülbül, 2021; Kim and Son, 2014). The high number of hemiplegic patients who did not use assistive devices and orthoses, the low level of GMFCS in the hemiplegia group, and the lower scores of the locomotion and transfers subgroup from WeeFIM scores, and the worse balance control in the diplegia group all make a significant contribution to this situation.

Our research has some limitations. The first limitation was the low number of participants, while the second limitation was not adding rehabilitation sessions before using the assessment tools, as some participants may have had better training in the past, resulting in better performance than others. In conclusion, the hemiplegic group had considerably better walking, balance, and lower limb function than the diplegic group, but had substantially weaker upper limb performance. Based on the findings, researchers recommend that physiotherapists examine approaches to promoting functionality in the lower limbs of diplegia and the upper extremities of hemiplegia. The researchers believe that larger research is needed to study the functional characteristics of diplegia and hemiplegia cerebral palsy.

5. CONCLUSION

This study provides objective evidence of the significant differences in functional walking ability, balance, and functional independence between children with hemiplegia and diplegia. What is possibly more relevant is that children with the same mobility classification level exhibit a clear and persistent pattern of differences, with hemiplegia showing significantly higher gait and lower-extremity mobility scores than diplegia. The fact that children with hemiplegia often have inadequate self-care abilities and poorer upper extremity function gives support to a set of measures for assessing upper extremity function. Based on the results of the study, the researchers suggest developing physiotherapy interventions or modalities adapted to the kind of CP and limitations experienced by people with CP to improve their ability to do functional activities with greater independence.

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Conflict of Interest

"The authors declare that they have no conflicts of interest".

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