JETR

JOURNAL OF
EXERCISE THERAPY
AND REHABILITATION

Journal of Exercise Therapy and Rehabilitation. 2024;11(2):132-141. DOI: 10.15437/jetr.1292901

ORIGINAL ARTICLE

Relation between balance, functional mobility, walking endurance and participation in ambulatory children with spastic bilateral cerebral palsy - Balance and participation in cerebral palsy

Yürüyebilen spastik bilateral serebral palsili çocuklarda denge, fonksiyonel mobilite, yürüme enduransı ve katılım arasındaki ilişki - Serebral palside denge ve katılım

Zana GERGİ AHMETİ[1], Kubra SEYHAN BIYIK[2], Mintaze KEREM GÜNEL[2], Gül YAZICIOĞLU[2]

Abstract

Purpose: This study aimed to investigate the relationship between balance, functional mobility, walking performance and level of participation in ambulatory children with cerebral palsy.

Methods: the study included 43 children with spastic bilateral cerebral palsy and 26 children with typical development. Mobility of children with cerebral palsy was evaluated with Gross Motor Function Classification System, in which 18 of them were in level I and 25 children in level II. Balance skills and functional mobility were evaluated with Pediatric Balance Scale, Timed Up and Go Test, and 1 Minute Walk Test in children with cerebral palsy and typical development. Pediatric Outcome Data Collection Instrument was used to assess the participation level of children of two groups. The differences between groups were determined by Kruskall Wallis test and the Spearman Correlation test was used to analyze the relationship between functional balance, activity, and participation.

Results: Compared to children with typical development, balance skills were found to be lower in children with cerebral palsy (p:0.001). Balance status were correlated positively with walking performance (r:0.631) and activity of participation (r:0.796), but negatively (r:-0.774) with functional mobility in children with cerebral palsy.

Conclusion: The impairment of balance skills in children with CP reduces the levels of mobility, transfer, functionality and participation in daily life activities. As dynamic balance skills increase, functional balance, mobility level and social functions also improve.

Keywords: Cerebral palsy, Participation, Postural balance.

Öz

Amaç: *Bu çalışma yürüyebilen serebral palsili çocuklarda denge, fonksiyonel mobilite, yürüme performansı ve katılım düzeyi arasındaki ilişkisinin araştırılması amacıyla yapılmıştır.*

Yöntem: *Çalışmaya bilateral spastik serebral palsili 43 çocuk ve tipik gelişim gösteren 26 çocuk dahil edildi. Serebral palsili çocuklarda mobilite Kaba Motor Fonksiyon Sınıflandırma Sistemi ile değerlendirildi; bunların 18'i seviye I, 25'i ise seviye II idi. Serebral palsili ve tipik gelişim gösteren çocuklarda, denge becerileri ve fonksiyonel hareketlilik, Pediatrik Denge Skalası, Süreli Kalk ve Yürü Testi ve 1 Dakika Yürüme Testi ile değerlendirildi. İki gruptaki çocukların katılım düzeyini değerlendirmek için Pediatrik Sonuç Veri Toplama Aracı kullanıldı. Gruplar arasındaki farklar Kruskall Wallis testi ile belirlendi ve fonksiyonel denge, aktivite ve katılım arasındaki ilişkinin analizinde Spearman Korelasyon testi kullanıldı.*

Bulgular: *Serebral palsili çocuklarda denge becerileri normal gelişim gösteren çocuklara göre daha düşük olduğu belirlendi (p:0,001). Serebral palsili çocuklarda denge durumu, yürüme performansı (r:0,631) ve katılım aktivitesi (r:0,796) ile pozitif, fonksiyonel hareketlilik ile ise negatif (r:-0,774) ilişkili olarak bulundu.*

Sonuç: *SP'li çocuklarda denge becerilerinin etkilenimi, hareketlilik, transfer, işlevsellik ve günlük yaşam aktivitelerine katılım düzeylerini azaltmaktadır. Dinamik denge becerileri arttıkça fonksiyonel denge, mobilite düzeyi ve sosyal işlevler de gelişmektedir.*

Anahtar kelimeler: *Serebral palsi, Katılım, Postural denge.*

1: University of Gjakova 'Fehmi Agani' Faculty of medicine, Department of Physiotherapy, Gjakova, Kosovo.
2: Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Ankara, Türkiye.
Corresponding Author: Zana Gergi: gergizana@gmail.com
ORCID IDs (order of authors): 0000-0002-4647-2914; 0000-0001-7943-4255; 0000-0003-4942-5272; 0000-0002-8063-7233
Received: May 5, 2023. Accepted: March 11, 2024.

INTRODUCTION

Cerebral Palsy (CP) is a clinical picture seen in early childhood characterized by functional impairment that affects the development of movement and postural control.[1] Brain damage and neurological impairments like spasticity, muscle weakness, co-contractions and visual impairments can affect the development of movement and posture in children with CP. According to studies, children and adults with CP are have postural impairments that may affect on daily life activities. Balance is defined as the ability to maintain the body center of mass within the support surface and consists of vestibular, visual, auditory, proprioceptive and upper level premotor systems. Problems such as abnormal motor control, persistence of primitive reflexes, formation of contractures or abnormal posture seen in children with CP may negatively affect balance.[2] Children with spastic CP are divided into unilateral (hemiplegic) and bilateral (diplegic and quadriplegic) according to the body involvement.[2]

"Walking by falling" due to insufficient postural control is one of the conditions encountered in children with spastic diplegic or bilateral CP. Fear of falling can lead to restriction of activities, they may result in pain, injury and disability.[1,2]

Approximately 60-70% of children with bilateral CP walk independently with or without restrictions outside the house and at a greater distance[3]. They face challenges like physical limitations, poor socialization, limited recreational activities, and stigmatization. Children with bilateral CP have a reduced ability to adapt sensory and motor components of postural control that come up from environmental factors affecting their response to react to different threats or to recover from unexpected situations. Also, functional balance problems affect their walking activity, which is characterized by falls, reducing their confidence to perform daily life activities.[4] Ambulatory children with CP may participate in physical activities and sports depending on their physical preferences and environmental conditions. They can walk in most environments but may have difficulty balancing on long-distance walks, uneven surfaces, or crowded areas. Also, in the community, they can walk with physical assistance. They may need some modifications to take part in physical activities.[5]

Sahoo, Rege, Rao et al.[6] stated that children with CP had limited social participation in different contexts and activities by their level of severity of motor impairment. Since 2007, assessment of body structure and function, as well as activity and participation dimension in children with CP within the scope of International Classification of Functioning, Disability and Health: Children and Youth Version (ICF-CY) provided a holistic perspective according to World Health Organization. Supporting the social life roles of children with CP has been an important goal of rehabilitation approaches.[7]

In this study, it was hypothesized that in ambulatory children with spastic bilateral CP, functional balance performance was lower than those with TD and the level of participation would change as the balance performance of children changed. Therefore, this study aimed to show the differences in functional balance performance between children with bilateral CP and TD children by assessing practical and precise balance measurements in order to investigate the relationship among the functional balance performance, daily life activities, and participation status of children with spastic bilateral CP.

METHODS

Participants

This study was carried out in Hacettepe University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Cerebral palsy and pediatric rehabilitation unit in order to evaluate the effect of balance disorders on activity and participation in ambulatory children with CP. The sample of the study was selected from the children with CP and their parents who came for home program education. Children included in this study were followed by a home tracking program like 2-3 days a week, by the same physiotherapist, regularly. Also, they were applying the home program given by the physiotherapist. The parents were informed about the study and written consent was obtained from those that received to take part in

the study. This study included ambulatory children who were diagnosed with spastic bilateral CP at GMFCS level I and II and their parents those who can read and write in Turkish, in the range of age from 6-12 years. Included children had no joint limitation or any presence of contractures. The most common walking patterns observed in the children included in the study were crouch gait and toe walking.

All included children with CP were using AFO for 4-6 hours per day. Exclusion criteria were: non-ambulatory children with CP, different clinical type (dyskinetic, ataxia, etc.), having a severe type of GMFCS level, having a chronic disease like asthma or respiratory problems, severe visual, cooperation or cognitive problem, botulinum toxin injection, or orthopedic surgery at last six months.

Since these assessment tests did not have cut-off values to show balance disorder in the Turkish population, these assessment methods were applied to 26 children with TD to differentiate them from children with CP and functional balance performances were compared. Inclusion criteria for children with TD were: being in the same age (6-12 years) with the other group of children, having no chronic disease and having no any fracture or orthopedic surgery for any reason in the last 6 months.

Sample size was calculated by the G*Power Version 3.1.9.6 analyses program. The sample size estimations were done according to an observed effect size of d=1.43 and reported for PBS total score between children with CP at GMFCS level I and II[8]. To obtain 95% power to detect a difference with a 95% confidence interval using a two tailed test, as a minimum 15 children with CP were required for each group.

Demographic data were taken from their parents: gender, age, diagnosis, use of the assistive device, and the existence of secondary problems. Gross motor function and functional balance performance measurements were applied in the clinical setting.

Measurements

Gross Motor Function Classification System (GMFCS): GMFCS was used to classify the gross motor functions of children with CP in five levels between level I and V and was created by Palisano, Rosenbaum, Walter et al.[9]. While children with CP of level I can walk and run at home, school or outside, but may need speed and coordination for some activities, children with CP of level V are those who need transport and assistance and have difficulties on maintaining movements of the upper and lower extremity.

In this study, ambulatory children were classified by a physiotherapist according to the Turkish version of GMFCS, which was prepared by Günel et al.[10] Children of level I can walk and climb and show motor skills like running and jumping but their speed is limited in balance and coordination. Children of level II can walk short distances indoors on smooth surfaces outside the home without the need for a hand-held mobility device, but they cannot run or jump. They may have difficulty walking long distances, uneven surfaces, or restricted areas. In the community, children can walk with physical assistance or hand-held mobility devices.[9]

Pediatric Berg Balance Scale (PBS): PBS was used to evaluate the balance control in children with CP and is composed of 14 items like sitting balance, standing balance, transfers, stepping, etc. Each item is scored 0-4 points and all of them are assessed as static balance, dynamic balance, and a total one[11]. Turkish version of the PBS has high interrater (ICC=0.915), and intra-rater (ICC=0.927) reliabilities in children with CP are as shown. Permission to use the Turkish version of the PBS obtained from the author and the Turkish version was used in this study.[12]

Timed Up and Go Test (TUG): TUG measures functional mobility, balance, and anticipatory postural control in children with CP. The test is applied three times and the mean score is used to name a result. If needed, assistive devices can be used for the lower extremity. The time of the test is calculated from the start position to the end one. The TUG test had high test-retest reliability (ICC=0.98–1.00) in children with CP.[13]

One Minute Walking Test (1MWT): 1MWT assesses the walking endurance and functional ability in ambulatory children with CP. Throughout the test, maximum walking speed is assessed during 1 minute in 20 meters distance. Then, dynamic balance and muscle performance are determined by test. The test-retest reliability of the 1MWT to assess walking speed is regarded as high (ICC=0.94).[14,15]

Pediatric Outcome Data Collection Instrument (PODCI): Turkish version of the PODCI, translated by one of the co-authors, was used in this study. The valid and reliable Turkish version of PODCI was used to assess the level of activity, participation, physical function, and functional health status in children with CP. The PODCI can be used in children with a range of ages from 2-18 years and contains the assessment of upper extremity functions (PODCI-UE) physical function, and sport (PODCI-S), transfers and mobility (PODCI-TM), pain (PODCI-P), happiness (PODCI-H) and expectations from therapy (PODCI-G). Test-retest reliability is shown to be high (Alpha=0.93, ICC=0.99).[16] The PODCI-parent questionnaire was applied one by one to mothers who were Turkish and high school graduates.

All the functional balance tests were applied on the same day by giving a rest time of 5-10 minutes between the tests.

Statistical analysis

Statistical analysis was done by IBM SPSS Statistics for Windows (Version 21.0. Armonk, NY: IBM Corp). Children were classified due to group of level I and level II according to GMFCS and TD ones. The compatibility of the data with normal distribution was reviewed visually (probability plots and histograms) and through analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's test). The measurement data were indicated as the mean and standard deviation (SD). The data indicated by numbers were evaluated as number (n) and percentage (%). The age, height, weight, body mass index, PBS, TUG, 1 MWT, PODCI sub-scales, and PODCI global scores were compared by Kruskal-Wallis Test. The relationship between balance status, walking performance, and participation levels were analyzed by Spearman Correlation Test. The value of statistical significance was set at $p<0.05$. Cohen's recommendations for characterizing the strength of a correlation coefficient were applied: 0.15-0.29, weak; 0.30-0.49, moderate; 0.50-0.99, strong.[17]

RESULTS

Demographic characteristics of children: due to age, height, and weight there were no differences between children of both groups. Forty-three children with spastic bilateral CP and twenty-six TD children were

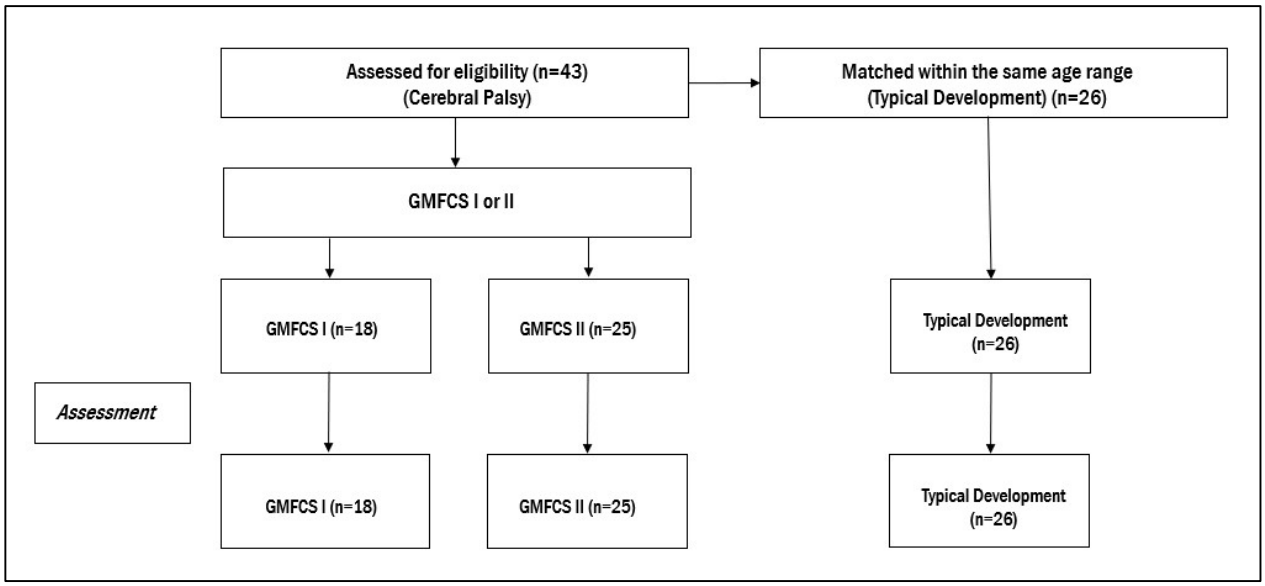

Figure 1. Flowchart of the study.

included in the study. Eighteen children with CP were in level I, twenty-five in level II of GMFCS. The mean age of children with GMFCS level I was 8.90±0.73 (8-10) years, the other group of GMFCS level II had a mean age of 9.20±1.58 (6-12) years, and TD children had 9.20±1.57 years (Table 1). Due to the functional balance skills of children, there were statistical differences between children with CP at GMFCS level I and II, and TD children (p:0.001) (Table 2). Children with CP had lower scores than children with TD.

It was found that there was a statistically significant difference in the scores obtained by the children in terms of the time they covered during walking ($p<0.05$, Table 2). According to the test results, the TUG mean score of children with CP was higher than the average score of TD children. Additionally, children of level I had a lower score of the TUG compared to those of level II (p:0.001). There were found differences between 1MWT scores between children with CP and TD ones (p:0.001) and there was a difference in the CP group where children of level I had better performance than children of level II under the 1MWT test (p:0.001) (Table 2).

Balance skills, walking performance and the levels of social participation of children with spastic bilateral CP included in this study were given in Table 3.

There were found a strong relationship between balance skills and participation level in daily life activities (r=0.796). Especially, a correlation between balance skills and the range of pain in children with CP (r:0.736) and also one with upper extremity skills (r:0.744) was found to be significant.

Participation scores of ambulatory children with spastic bilateral CP were negatively correlated with walking performance (r=-0.678) and moderately with one-minute walk test (r=0.513). Due to results, there were significant negative correlations between walking time and the level of pain in children with CP (r:-.610), also found moderate correlations between sport activities and distance of time recorded during one minute (r:0.512*) (Table 3).

While there was a strong negative correlation between functional balance and time taken during the test (r=- 0.774), there was a positive one with distance recorded in one minute (r =0.631) (Table 3).

DISCUSSION

This study examined functional balance performance, the relationship between balance status and activity-participation level of spastic bilateral children with CP in daily life and social life, and compared them with TD children. This study did found that balance problems besides motor functions were related to participation level in daily living activities where children with CP got lower points than their TD peers. Additionally, impairment of balance skills in children with CP can affect functionality, mobility, and transfer in daily life activities.

Due to the literature, there are limited tools to assess balance skills in children with CP. The PBS and TUG are two important tests used to define the quantitative values of the balance in children with CP.[15,16] Kembhavi, Darrah, Magill-Evans et al.[18] stated that the PBS was useful, functional, and easy to evaluate balance function. In this study in order to see the difference between children with CP and TD children, the PBS was used beside TUG and 1MWT. As expected, significant differences were found between groups where children with CP had lower scores than their TD peers. This study also investigated the difference between GMFCS level I and II due to balance skills where it was found a significant difference between the two groups. Balance scores of children of level I were higher than children of level II which showed us that despite improved mobility, children of level I had more coordination and balance problems especially on activities that require a speed or move over uneven places. Hassani, Krzak, Johnson et al.[15] compared TUG and 1MWT values between ambulatory children with CP and stated that those scores differ throughout GMFCS level, where the impairment level increases, time in TUG increases but the distance in 1MWT decreases. In this study, TUG and 1MWT were used to evaluate the differences between children with CP and children with TD and both groups differed from each other due to their scores and children with CP were affected despite their high level of mobility, dynamic balance skills and postural control. Under the GMFCS level, due to TUG, there was no big difference between children of level I and level II. It can be said that if impairment increases,

Table 1. Demographic characteristics of the children.

	Cerebral Palsied			
	GMFCS I (N=18)	GMFCS II (N=25)	Typical Development (N=26)	
	X±SD	X±SD	X±SD	p (a)
Age (years)	8.90±0.73	9.20±1.58	9.20±1.57	0.760
Height (cm)	131.90±9.01	126.40±7.02	137.35±13.56	0.170
Body weight (kg)	28.70±5.60	33.20±4.73	30.85±7.40	0.605

(a): Kruskal-Wallis Test. GMFCS: Gross Motor Function Classification System.

Table 2. Data obtained in groups and comparison between groups.

	Cerebral Palsied				
	GMFCS I	GMFCS II	Typical Development		
	X±SD	X±SD	X±SD	p (a)	(b)
One Minute Walk Test (1MWT) (m)	60.30±6.70	53.70±13.34	71.50±11.12	<0.001	I-TD, I-II, II, TD
Timed Up and Go Test (TUG) (sec)	8.46±1.00	9.10±1.19	6.40±0.94	<0.001	I-TD, I-II, II, TD
Pediatric Balance Scale (PBS)	50.60±2.95	46.60±6.02	55.85±0.56	<0.001	I-TD, I-II, II, TD
PODCI					
Upper Extremity	78.30±4.44	68.08±4.69	95.50±11.86	<0.001	TD-II, TD-I
Transfer	84.60±4.47	78.67±4.53	97.73±5.86	<0.001	TD-II
Sport	67.20±5.18	48.42±4.44	90.18±16.09	0.007*	TD-II
Pain	86.10±6.48	76.67±4.77	97.32±6.91	<0.001	TD-II, TD-I
Happiness	75.20±4.78	71.08±2.93	95.41±11.89	0.013*	TD-II
Global	81.90±4.99	64.92±5.05	94.92±8.36	<0.001	TD-I, TD-II, I-II

* p<0.05. (a): Kruskal-Wallis Test. (b): Differences between two paired comparisons. PODCI: Pediatric Outcome Data Collection Instrument. GMFCS: Gross Motor Function Classification System.

Table 3. The relationship among the functional balance tests and participation level of ambulatory children with spastic bilateral cerebral palsy (N=43).

	Pediatric Balance Scale (PBS)	Timed Up and Go Test (TUG)	One Minute Walk Test (1MWT)
	rho	rho	rho
Pediatric Outcome Data Collection Instrument			
Upper Extremity	0.744**	-0.566**	0.473**
Transfer	0.595**	-0.457**	0.371**
Sport	0.460**	-0.547**	0.512**
Pain	0.736**	-0.610*	0.535*
Happiness	0.503**	-0.369*	0.300*
Global	0.796*	-0.678*	0.513**
Timed Up and Go Test (TUG)	-0.774**		
One Minute Walk Test (1MWT)	0.631**		

* p< 0.05. ** p<0.01. rho: Spearman Correlation coefficient.

the time required to complete TUG will increase too. Otherwise, 1MWT differed between two groups where emphasized that by the increasing of GMFCS level, walking distance will decrease.

Gan, Tung, Tang et al.[19] stated a negative relationship between the PBS and TUG scale, high PBS scores were associated with decreased walking speed and increased walking time. They found a strong correlation between motor function and balance skills, where the PBS was found to be an evaluation of standing and walking abilities under the balance functions. In the current study, there was a positive strong correlation between balance activity and functional mobility, and a negative strong one with walking performance. Development of dynamic balance and static balance skills in children with CP would lead to better motor performance, faster-walking speed of the walk, and longer walking distance. The results were in the same line as those of Gan, Tung, Tang et al.[19]

Barnes, Linton, Sullivan et al.[20] investigated a study that established the values of Parent PODCI by age and GMFCS in ambulatory children with CP. Children with CP scored between 72.9-81.3 for children of GMFCS-I and 66.6-73.3 for those with GMFCS-II. In this study, ambulatory children with spastic bilateral CP had lower points than children with TD. The results were divided into two groups, under the GMFCS level and due to PODCI-Global, children of GMFCS Level I (81.90) had higher results than those of level II (64.92). Although being a functional children, group of GMFCS-II level are those who need physical support to carry out their transfers in the community, which demonstrates their difference from group of GMFCS-I level.

Despite PODCI global results, there were found differences between PODCI-UE, Transfer, Sport, and Pain. According to the PODCI-UE results, compared to children of level I, which has no restrictions in performing daily activities, it can be deducted that being a GMFCS-II child, alternative ways may be needed to perform some hand activities.

Due to the results of this study, it can be stated that the increase in the level of GMFCS affects functions such as transfer and mobility. As the capacity of children with CP to perform functional skills increases, their transfer and mobility levels will be positively affected, and that these can have an effect on the levels of participation in areas such as social function and self-care under daily life activities and that their level of independence will increase. The type of CP, muscle strength, body composition, and gait disturbance are the components that determine the GMFCS level. The development of gross motor functions in children with CP is important in terms of participating in daily life activities and increasing the quality of life. The decrease in the severity of the exposure may cause an increase in walking activity in children with CP and reduce the time during walking. As the walking performance increases, the individual can also improve the parameters under walking and participate in daily life activities.

An increase of physical state for children with CP means having more endurance and muscle force for the sports skills and this leads them to reverse to their TD peers. Being pre-adolescents, in adolescence, aware of their physical performance, and increasing their body awareness may affect their average scores. This will impact social activities especially. Under the PODCI-Pain, the presence of spasticity may bring pain together with the increase in the intensity of the exposure and the pain can increase especially towards adolescence.

Mehraban, Hasani and Amini[21] investigated on participation activities of school-aged children with CP and emphasized that participation played an important role in the health and development of children was an influential factor in gaining independence in adulthood. The main goal of rehabilitation for school-age children with CP was to develop independence in self-care and mobility. Oeffinger, Gorton, Bagley et al.[22] stated that in addition to insufficient physical activity, decreased muscle strength, spasticity, balance-coordination disorders, and gait disorders, environmental and personal factors were also that limit the daily life activities of children with spastic bilateral CP. PODCI-Global results differed between two groups based on the purpose that mild impairment harmed their daily life activities and participation state that children with spastic bilateral CP may need some modifications to take part in physical activities and social participation. By being a child with an ability to walk, run and jump without assistance they may participate in sports activities depending on their physical

preferences and environmental conditions. In the current study, strong results were found between balance status and daily life activities, and participation level.

Children with CP, as one of the most impaired group under the children with disabilities, are face to face with limitations in activities, lower involvement in the community, sport, and recreational activity which can affect their mood, cognitive and anxiety state.[23,24] Moraes, Copetti, Angelo et al.[25] also found a strong correlation between balance skills and mobility, social functions, and self-care activities in a study composed of 15 children with CP aged 5-15 years old and stated that balance development would be reflected on functional balance too. PODCI was used to evaluate the performance in daily life activities of children with CP and found a moderate result between PBS and the items of PODCI, especially in physical, sport, and global functions. In children with CP, the development of balance skills and motor performance affect their daily activity. Children of level I-II of GMFCS were included and so the increase of impairment level can impact transfer and mobility functions. By the improvement of functional and balance skills of children with CP, an increase of transfer and mobility state will lead to enhancement of self-care, social function, and also sport and physical performance.[26-28] In this study, a strong relation were found between balance skills and participation activities so the increase in balance skills, motor performance, and capacity in children with CP affects the level of activity and participation in daily life. Considering that included children have levels of GMFCS-I and II , it can be stated that the increase in the level of influence affects functions such as transfer and mobility. Increasing social participation and daily life activities in children with CP will make them more functional and will increase their mobility level and speed by decreasing the time required to complete the activity and decrease the gait distance.

As the capacity of children with CP to perform functional skills increases, their transfer and mobility levels will be positively affected and these will have an effect on the levels of participation in areas such as social function and self-care under daily life activities, so their independence level will be increased.

Limitations

The study included only children with spastic bilateral CP. Children with spastic unilateral CP weren't included in order of having one half of the body unimpaired and this could affect the balance results. One of our limitations was lack of technological-based balance assessments was one of our limitations. Also, the absence of spasticity and range of motion evaluation were the other limitations in order to have a more detailed results.

Conclusion

Loss of balance in children with spastic bilateral CP related to low functionality and limited participation levels. Balance impairment is associated with walking performance, children with CP included in this study were characterized by crouch gait and toe walking. The development of dynamic balance may increase functional balance, mobility level, and social functions of children with spastic bilateral CP. Especially, low functional balance performance may be one of the key barriers for limited social participation of ambulatory children with spastic bilateral CP. Looking forward, it is thought to be important to evaluate functional balance and coordination problems with a more detailed and practical in clinical settings and also in different environments (home, school, or community) in a more involved population with different clinical types of CP. In the literature, it is noteworthy that there are fewer evaluations of balance and coordination disorders in children with CP compared to children with typical development. We believe that our study will contribute to the evaluation of the effects of balance and coordination problems of children with CP on their activity and participation levels compared to typically developing children.

Acknowledgement: The authors would like to thank all the families and children who participate in this study and who shared their thoughts and time with us.

Authors' Contributions: ZG: Literature search, data acquiring; **KSB:** Study design, concept, case referral; **MKG:** Study design, project administration, critical reviewing; **GY:** project administration, critical reviewing.

Funding: *None*

Conflicts of Interest: *None*

Ethical Approval: The protocol of the present study was approved by the Hacettepe University, Clinical Research Ethics Committee (issue: GO 16/653 -19 25.10.2016).

REFERENCES

1. Gunel MK, editor. Cerebral palsy: Current steps. Definition, Epidemiology, and Etiological Factors of Cerebral Palsy. Kurt E. BoD–Books on Demand; 2016;4-5.
2. Saether R, Helbostad JL, Riphagen II, Vik T. Clinical tools to assess balance in children and adults with cerebral palsy: a systematic review. Dev Med Child Neurol. 2013;55:988.
3. Beckung E, Hagberg G, Uldall P, Cans C, Surveillance of Cerebral Palsy in Europe. Probability of walking in children with cerebral palsy in Europe. Pediatrics. 2008;121:e187-92.
4. Freeborn D, Knafl K. Growing up with cerebral palsy: perceptions of the influence of family. Child Care Health Dev. 2014;40:671-9.
5. Alriksson-Schmidt A, Nordmark E, Czuba T, Westbom L. Stability of the Gross Motor Function Classification System in children and adolescents with cerebral palsy: a retrospective cohort registry study. Developmental Medicine & Child Neurology. 2017;59:641-6.
6. Sahoo R, Rege S, Rao S. Social Participation in Children with Cerebral Palsy. Online J Health Allied Scs. 2017;16:5.
7. Schiariti V, Mahdi S, Bölte S. International Classification of Functioning, Disability and Health Core Sets for cerebral palsy, autism spectrum disorder, and attention-deficit–hyperactivity disorder. Dev Med Child Neurol. 2018;60:933-41.
8. Kwon JY, Chang HJ, Yi SH, Lee JY, Shin HY, Kim YH. Effect of hippotherapy on gross motor function in children with cerebral palsy: a randomized controlled trial. J Altern Complement Med. 2015;21:15-21.
9. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Gross motor function classification system for cerebral palsy. Dev Med Child Neurol.1997;39:214-23.
10. El Ö, Baydar M, Berk H, Peker Ö, Koşay C, Demiral Y. Interobserver reliability of the Turkish version of the expanded and revised gross motor function classification system. Disabil Rehabil. 2021;34:1030-33.
11. Chen CL, Shen IH, Chen CY, Wu CY, Liu WY, Chung CY. Validity, responsiveness, minimal detectable change, and minimal clinically important change of Pediatric Balance Scale in children with cerebral palsy. Res Dev Disabil. 2013;34:916-22.
12. Erden A, Acar Arslan E, Dündar B, Topbaş M, Cavlak U. Reliability and validity of Turkish version of pediatric balance scale. Acta Neurologica Belgica. 2021;121:669-75.
13. Dhote SN, Khatri PA, Ganvir SS. Reliability of "Modified timed up and go" test in children with cerebral palsy. J Pediatr Neurosci. 2012;7:96-100.
14. McDowell BC, Kerr C, Parkes J, Cosgrove A. Validity of a 1 minute walk test for children with cerebral palsy. Dev Med Child Neurol. 2005;47:744-8.
15. Hassani S, Krzak JJ, Johnson B, Flanagan A, Gorton III G, Bagley A, et al. One-Minute Walk and modified Timed Up and Go tests in children with cerebral palsy: performance and minimum clinically important differences. Dev Med Child Neurol. 2014;56:482-9.
16. Keskin Dilbay N, Kerem Günel M, Aktan T. Pediatrik Veri Toplama Aracının (PVTA) Türkçe versiyonunun serebral palsili bireylerde geçerlik ve güvenirliği. Fizyoter Rehabil. 2013;24:118-126.
17. Faul F, Erdfelder E, Lang AG, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39:75-191.
18. Kembhavi G, Darrah J, Magill-Evans J, Loomis J. Using the berg balance scale to distinguish balance abilities in children with cerebral palsy. Pediatr Phys Ther. 2002;14:92-9.
19. Gan SM, Tung LC, Tang YH, Wang CH. Psychometric properties of functional balance assessment in children with cerebral palsy. Neurorehabil Neural Repair. 2008;22:745-53.
20. Barnes D, Linton JL, Sullivan E, Bagley A, Oeffinger D, Abel M, et al. Pediatric outcomes data collection instrument scores in ambulatory children with cerebral palsy: an analysis by age groups and severity level. J Pediatr Orthop. 2008;28:97-102.
21. Mehraban AH, Hasani M, Amini M. The comparison of participation in school-aged Cerebral Palsy children and normal peers: A preliminary study. Iran J Pediatr. 2016;26:e5303.
22. Oeffinger D, Gorton G, Bagley A, Nicholson D, Barnes D, Calmes J, et al. Outcome assessments in children with cerebral palsy, part I: descriptive characteristics of GMFCS Levels I to III. Dev Med Child Neurol. 2007;49:172-80.
23. Park ES, Rha D-W, Shin JS, Kim S, Jung S. Effects of hippotherapy on gross motor function

and functional performance of children with cerebral palsy. Yonsei Med J. 2014;55:1736-42.
24. Sadowska M, Sarecka-Hujar B, Kopyta I. Cerebral Palsy: Current Opinions on Definition, Epidemiology, Risk Factors, Classification and Treatment Options. Neuropsychiatr Dis Treat. 2020;16:1505-18.
25. Moraes AG, Copetti F, Angelo VR, Chiavoloni LL, David AC. The effects of hippotherapy on postural balance and functional ability in children with cerebral palsy. J Phys Ther Sci. 2016;28:2220-6.
26. Alghamdi MS, Chiarello LA, Palisano RJ, McCoy SW. Understanding participation of children with cerebral palsy in family and recreational activities. Res Dev Disabil. 2017;69:96-104.
27. El-Shamy SM, Abd El Kafy EM. Effect of balance training on postural balance control and risk of fall in children with diplegic cerebral palsy. Disabil Rehabil. 2014;36:1176-83.
28. Gainsborough M, Surman G, Maestri G, Colver A, Cans C, Surveillance of Cerebral Palsy in Europe collaborative group.Validity and reliability of the guidelines of the surveillance of cerebral palsy in Europe for the classification of cerebral palsy. Developmental Med Child Neurol. 2008;50:828-31.