H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
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Özgün Araştırma

Hemiplejik Serebral Palsili Adölesanlarda Gövde Kontrolü ve Dengenin İncelenmesi

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Öz

Amaç: Bu çalışmada, hemiplejik serebral palsili adölesanlarda gövde kontrolü ve dengenin tipik gelişim gösteren yaşıtları ile karşılaştırılması amaçlandı.
Gereç ve Yöntem: Çalışmaya 38 çocuk dahil edildi. Bu çocukların 19'u Kaba Motor Fonksiyon Sınıflandırma sistemine göre Seviye I ve II hafif etkilenimli 10-18 yaş arası SP'li çocuk iken (ortalama yaş 13,26±2,94 yıl), diğer 19'u ise tipik gelişim gösteren 10-18 yaş arası 19 adölesandan (ortalama yaş 13,57±2,85 yıl) oluşmaktaydı. Çocukların sosyodemografik bilgileri alındıktan sonra "Gövde Kontrol Ölçüm Skalası*"* (GKÖS) ile gövde kontrolü, Pediatrik Denge Skalası (PBS) ile denge değerlendirmesi yapıldı.
Bulgular: Çalışmanın sonucuna göre hemiplejik SP'li adölesanlar ile tipik gelişim gösteren yaşıtları arasında gövde kontrolü (%95 CI (50,65 – 54,65), p=0,001) ve denge (%95 CI (53,21 – 54,99), p=0,001) açısından anlamlı fark bulundu.
Sonuç: Bu çalışma, hafif etkilenimli SP'li adölesanların tipik gelişim gösteren yaşıtlarına kıyasla gövde kontrolü ve dengenin daha zayıf olduğunu göstermektedir. SP'li adölesanlarda etkilenim düzeyi hafif olsa da rehabilitasyon programlarına gövde kontrolünü ve dengeyi geliştirecek egzersizlerin eklenmesinin motor gelişime katkı sağlayabileceğini ve bu çalışmanın daha geniş bir örneklemle tekrarlanması gerektiğini düşünmekteyiz.

Anahtar kelimeler: *serebral palsi, postüral kontrol, denge*

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H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

Original Research

Investigation of Trunk Control and Balance in Adolescents with Hemiplegic Cerebral Palsy

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Abstract

Objectives: In this study, the aim was to compare trunk control and balance in adolescents with hemiplegic cerebral palsy (CP) to their typically developing peers.
Materials and Methods: Thirty-eight participants were included in this study. Nineteen of these children were Level I and II mildly affected children with CP between the ages of 10 and 18 according to the Gross Motor Function Classification system (mean age 13.26±2.94 years), while the other nineteen were typically developing adolescents between the ages of 10 and 18 (mean age 13.57±2.85 years). After sociodemographic information of adolescents was obtained, trunk control assessment was done with the Trunk Control Measurement Scale (TCMS) and balance assessment was made with the Pediatric Balance Scale (PBS).
Results: According to the results of the study, there was a significant difference in trunk control (95% CI (50.65 – 54.65), p=0.001) and balance (95% CI (53.21 – 54.99), p=0.001) between adolescents with hemiplegic CP and their typically developing peers.
Conclusion: This study demonstrates that adolescents with mild hemiplegic CP exhibit weaker trunk control and balance compared to their typically developing peers. Even though the level of impairment in adolescents with CP is mild, adding exercises to rehabilitation programs aimed at improving trunk control and balance may contribute to motor development. We believe that this study should be repeated with a larger sample size.

Keywords: *cerebral palsy, postural control, balance*

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H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

Introduction

Cerebral Palsy (CP) is a neurodevelopmental disorder that occurs in early childhood and continues throughout life (Bax et al., 2005). Although the primary injury is not progressive in CP, the severity of functional disabilities and handicap becomes progressive due to muscle tone, postural and movement disorders, sensory, mental, and behavioral disorders, and accompanying seizures (Ko et al., 2016; Smorenburg et al., 2011). In hemiplegic CP, the damage is limited to one side of the brain and causes various disorders and deficiencies in the lower and upper extremities on the opposite side of the lesion (Smorenburg et al., 2011).

Decreased selective motor control, muscle weakness, abnormal muscle tone, and coordination disorder between agonist-antagonist muscles; are possible causes of trunk control insufficiency in children with hemiplegic CP (Heyrman et al., 2014). Trunk control, is the base for stabilization and selective movements of the trunk (Kallem et al., 2019). Children with hemiplegic CP often have difficulty performing voluntary movements due to decreased muscle strength and abnormal muscle tone. As a result, they are unable to generate the necessary force to maintain their positions against gravity, leading to abnormal posture and balance (Brundavanam et al., 2015). Trunk control is a determinant of gross motor function and activities of daily living in children with hemiplegic CP (Tarfa et al., 2021). In addition, it is reported in the literature that children with hemiplegic CP have balance and coordination problems (Vitrikas et al., 2020). Balance is defined as the ability to control the body's position or the center of mass in space to maintain stability in a given environment (Liao & Hwang., 2003). The balance strategies of children with hemiplegic CP differ from those of children without neurological disorders. Children with hemiplegic CP show increased co-contractions in the distal and proximal pattern of muscle activation (Kembhavi et al., 2002). A significant positive correlation between trunk control and balance has also been demonstrated in children with hemiplegic CP aged between 5-12 and 8-14 years (Şimşek et al., 2017; Sivatejaa et al., 2017). It was stated that balance improved as trunk control increased (Şimşek et al., 2017; Sivatejaa et al., 2017). In the study conducted by Bingöl et al., Diplegic and Hemiplegic children with SP between the ages of 5-13 were compared in terms of trunk control and upper extremity skills and as a result, it was determined that hemiplegic children with SP had better trunk control and balance (Bingöl & Demirtaş Karaoba, 2024). In another study conducted by Bingöl et al., it was determined that trunk control and dynamic balance disorders negatively affected activity and participation (Bingöl & Demirtaş Karaoba, 2024). As a result of these studies, it was thought that the relation between trunk control and balance should be taken into

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

account in physiotherapy practices and evaluations. However, there is no embracing study in the literature examining the relationship between trunk control and balance in mildly affected adolescents with hemiplegic CP compared to typically developing adolescents.

Truncal control and balance in adolescents with mildly affected hemiplegic CP have not been previously compared with those of typically developing adolescents. The study was designed with the assumption that the trunk control and balance of adolescents with mildly affected hemiplegic CP could be more adversely affected compared to typically developing adolescents. We thought that revealing the differences in trunk control and balance between adolescents with mildly affected hemiplegic CP and adolescents with typically developing would guide the intervention protocols for adolescents with mildly affected hemiplegic CP. Therefore, this study aimed to examine trunk control and balance in adolescents with mildly affected hemiplegic CP compared to typically developing adolescents.

Materials and Methods

Prior to initiating this prospective study, ethical approval was secured from the Akdeniz University Faculty of Medicine Clinical Research Ethics Committee (16.02.2022/KAEK-98). The study adhered to the principles of the Declaration of Helsinki.

Participants

The participants consisted of adolescents with CP who came to a special education center in Antalya to receive a physiotherapy and rehabilitation program. The sample group of the study consisted of a total of 38 participants, including 19 adolescents with hemiplegic CP between the ages of 10-18 and 19 adolescents with typically developing between the ages of 10-18. Adolescents with typically developing groups were selected according to the same age group as the adolescents with CP. The information about the study and evaluation was given verbally to the parents of the adolescents who came to the special education center and met the inclusion criteria. Evaluations were carried out at the special education center.

The inclusion criteria for adolescents with CP were: (1) diagnosed with hemiplegic CP, (2) aged between 10-18 years, (3) being at ***GMFCS- ER*** level I and ***GMFCS- ER*** level II, (4) being able to communicate, (5) spasticity values in lower extremity muscles to be 2 or less according to Modified Ashworth Scale.

Exclusion criteria for adolescents with CP were: (1) botulinum toxin injection within 6 months, (2) selective dorsal rhizotomy within one year before the assessment date, (3) any lower extremity orthopedic surgery within one year before the assessment date; (4) severe vision,

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

hearing loss; (5) the presence of genetic and infectious disease.

Inclusion criteria for adolescents with typically developing were (1) to show typical motor development, (2) being between the ages of 10-18, and being able to communicate. Exclusion criteria for adolescents with typically developing were, (1) any orthopedic surgery in the year before the evaluation date, (2) severe vision, hearing, and loss, (3) the presence of genetic and infectious disease.

Based on the study titled "The relationship between trunk control in sitting and during gait in children and adolescents with cerebral palsy" (Sæther et al., 2015), the effect size was f=1.125, the margin of error was 0.05, and the power was 0.95. As a result of the analysis, the sample size was calculated as 19 individuals for each group, and the minimum sample size was 38 individuals.

Assessments

Participants were evaluated only once and no follow-up or implementation was made afterward. After recording the sociodemographic characteristics of the participants, including gender, age, height, and weight, the following evaluations were made.

***Gross Motor Function Classification System Expanded and Revised (GMFCS- ER)*:** The GMFCS-ER offers a framework to describe the functional abilities of children with CP across five levels (Palisano et al., 2008). It is a valid and reliable classification system, with a Turkish validity and reliability study conducted by El et al. (2012). In this study, children were categorized according to GMFCS-ER levels I and II. GMFCS-ER was used because individuals between the ages of 12-18 were included in the study.

Spasticity: Evaluation of lower extremity spasticity in children with CP was performed with the Modified Ashworth Scale (MAS), which has proven validity and reliability. MAS is a standardized, valid, and reliable method used to grade spasticity severity in children with CP (Yam & Leung., 2006; Heyrman et al., 2011). According to the resistance encountered on this scale, "0 = normal muscle tone, 1 = slight increase in muscle tone, minimal resistance at the end of the movement, 1+ = slight increase in muscle tone, minimal resistance in less than half of the movement, 2 = significant increase in muscle tone, the joint can still be moved, 3= significant increase in muscle tone, joint movement is very difficult, 4= joint is rigid, cannot be moved". Muscle tone measurement of the lower extremity was performed by choosing the appropriate position according to the evaluated extremity, on a bed of suitable hardness and width, with the child's head in the middle position, the lower and upper extremities as extended as possible, and in the supine position parallel to the trunk. In the present study, children were

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

included in the according to MAS value to be 2 or less.

Trunk Control Assessment: The trunk control of the children was assessed using the Turkish version of the Trunk Control Measurement Scale (TCMS), which was found valid and reliable (Özal et al., 2019). The scale includes parts: static sitting balance and dynamic sitting balance. The TCMS consists of a total of 15 items and the score ranges from 0 to 58. A higher score means improved trunk balance (Özal et al., 2019).

Balance Assessment: Balance of children was assessed using the Turkish version of the Pediatric Balance Scale (PBS), which has been validated and shown to be reliable by Erden et al. (Franjoine et al., 2003; Erden et al., 2012). This scale measures balance during activities such as sitting, standing up, standing with eyes open and closed, turning around, picking up objects from the ground, standing on one leg, and transferring. Each item is scored from 0 to 4 points, where a score of 0 indicates the task was not accomplished, and a score of 4 signifies that it was easily accomplished. The total score ranges from 0 to 56, with higher scores reflecting better balance performance (Franjoine et al., 2003; Erden et al., 2012).

Statistical Analysis

The data analysis was performed using "IBM SPSS Statistics 25" software. To assess the distribution of variables prior to test selection, one-sample Kolmogorov–Smirnov tests were employed. Descriptive statistics are represented as meansand standard deviation or as median and interquartile range, depending on whether they were parametric or non-parametricvariables. Data that did not follow a normal distribution were analyzed using the Mann-Whitney U test. TCMS and PMS score were comped with Mann-Whitney U test. A p-value of 0.05 was accepted significant.

Results

Forty-five participants accepted to participate in the study. However, two participants in the adolescents with CP group and five participants in the adolescents with typically developing group could not complete the assessments.

The mean age of adolescents with CP was 13.26 ± 2.94 years, and the mean age of adolescents with typically developing was 13.57 ±2.85 years. 73.7% (n=14) of adolescents with CP are at GMFCS-ER level I, while 26.3% (n=5) are at GMFCS-ER level II. Demographic information of the adolescents included in the study is given in Table 1. Descriptive data such as range of motion, and spasticity of adolescents with hemiplegic CP are given in Table 2.

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

Table 1. Frequency Distribution and Comparison of the Demographic Characteristics of the Participants

		Children with CP (n=19) X±SD	**Children with Typically Developing (n=19) X±SD**	**p**
Age (years)		13.26 ± 2.94	13.57 ± 2.85	0.11
Height (cm)		150.36±8.15	156.94±13.58	0.41
Weight (kg)		47.05±11.80	50.21±13.08	0.77
		n/%	n/%	
Gender	**Girl**	10/52.60	9/47.40	
	Boy	9/47.40	10/52.60	

n: Number, %: Percent X: Mean, SD: Standard Deviation, p* Mann Whitney-U Test.

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

Table 2. Descriptive Data of Children with Hemiplegic CP

	Children with CP (n=19) X±SD					
Hip (externel rotation/effected side)	36.36 ± 1.89					
Hip (externel rotation/non- effected side)	43.26 ± 2.37					
Hip (externel rotation/effected side)	36.00 ± 1.73					
Hip (externel rotation/non- effected side)	43.42 ± 2.33					
Spasticity (MAS)	**0** (n/%)	**1** (n/%)	**1+** (n/%)	**2** (n/%)	**3** (n/%)	**4** (n/%)
Hip flexion	19/100	0	0	0	0	0
Hip extension	19/100	0	0	0	0	0
Hip abduction	15/78.9	3/15.8	1/5.3	0	0	0
Hip adduction	14/73.7	3/15.8	2/10.5	0	0	0
Hip internal rotation	18/94.7	1/5.3	0	0	0	0
Hip external rotation	19/100	0	0	0	0	0
Hamstring	10/52.6	7/36.8	2/10.5	0	0	0
Quadriceps	15/78.9	2/10.5	2/10.5	0	0	0
Gastrocnemius	4/21.1	7/36.8	8/42.1	0	0	0
Gastrosoleus	4/21.1	7/36.8	7/36.8	0	1/5.3	0

n: Number, %: Percent X: Mean, SD: Standard Deviation. MAS: Modified Ashworth Scale.

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

A significant difference was found between the means of trunk control and balance variables in adolescents with CP and adolescents with typically developing (p=0.001). Adolescents with CP were less successful in trunk control and balance tests than the children with typically developing group (Table 3).

Table 3. Trunk Control and Balance Assessment of Children with CP and Typically Developing

	Children with CP (n=19) X±SD	**Children with Typically Developing (n=19) X±SD**	**p**
TCMS	47.31± 4.00	58± 0.00	0.001*
Static sitting	19.63±0.83	20.00±0.00	0.271
Dynamic sitting	18.00±3.10	28.00±0.00	0.001*
Dynamic reaching	9.68±1.00	10.00±0.00	0.583
PBS	52.21±2.76	56± 0.00	0.001*

TCMS: Trunk Control Measurement Scale; PBS: Pediatric Balance Scale; X: Mean, SD: Standard Deviation, p<0.05*, Mann-Whitney U test.

Discussion

This study compared trunk control and balance in mildly affected adolescents with hemiplegic CP with a typically developing control group. According to the study results, trunk control and balance outcomes of adolescents with mildly affected hemiplegic CP were lower than their typically developing peers.

According to Malone et al. (2016), which included children with mildly affected hemiplegic CP and typically developing children, and compared trunk control and balance by kinematic analysis, it was determined that trunk control and trunk compensation in children with CP were higher than in children with normal development. Donker et al. (2008), determined that trunk control of children with CP is poorer when compared to children with typically developing, and they are worse than children with typically developing in terms of balance parameters. In summary, the findings of the present study align with existing literature. However, there is no study comparing the trunk control and balance of adolescents with mildly affected CP and adolescents with typically developing. In this respect, our study is the first to indicate that the trunk control and balance of adolescents with mildly affected hemiplegic CP in adolescence are lower than those of typically developing adolescents.

As a result of the study by Panibatla et al. in which 24 children with CP between GMFCS-ER levels I-III were included, trunk control and balance were found to have a positive

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

correlation with each other (Sivatejaa et al., 2017). In the study of Özal and Günel (2014), where they evaluated 19 children with spastic CP between the ages of 5-17, it was determined that trunk control was related to postural control and balance. In the current study, the relationship between trunk control and balance between GMFCS-ER levels I and II was not determined due to insufficient sample size. In future studies, the relationship between trunk control and balance in adolescents with hemiplegic CP should be explored in relation to GMFCS-ER levels.

It is known that impaired trunk control and balance in children with CP lead to reduced upper extremity control. Inability to establish proximal stabilization during postural adjustments and increased activation of extremity muscles during limb movements result in diminished functionality during limb movements (Akbaş & Günel, 2019). In the randomized controlled study conducted by Akbaş and Günel (2019) on 36 children with bilateral spastic CP, it was determined that the group receiving trunk training showed a greater improvement in upper extremity functions compared to the group that did not receive trunk training. In the study conducted by Yıldız et al. (2018), 32 children with bilateral CP between the ages of 5-12 were included, and a relationship was found between trunk control and upper extremity functions. Our study examined the relationship between trunk control and balance in adolescents with hemiplegic spastic CP compared to typically developing adolescents. Upper extremity functions and trunk control and balance relationship was not investigated. In future studies, this subject should be explored in adolescents with hemiplegic spastic CP.

The results of the study conducted by Kim et al. (2018), on children with hemiplegic and diplegic CP indicate that there is a relationship between trunk sway, which is a parameter of balance, and trunk control. In a different study investigating the clinical characteristics of trunk control in CP, the participants achieved 66% of the maximum score on the TCMS overall. In addition, it was determined that the least affected type of trunk control was hemiplegic CP. Although the hemiplegic type is the least affected type of CP among all types of CP, it has been determined that trunk control and balance parameters are worse than children with typically developing according to current study results (Heyrman et al., 2013). In this context, it was thought that a physiotherapy program should be created to improve trunk control and balance when determining intervention programs.

Limitations

The limitation of this study is that it only includes individuals with hemiplegic CP among adolescents. In the future, studies assessing different types of CP in terms of trunk control and balance during adolescence could be planned. Another limitation of this study was

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

the insufficient sample size to determine the relationship between trunk control and balance among levels of GMFCS-ER in adolescents with spastic CP. Future studies can compare GMFCS-ER levels in terms of trunk control and balance parameters.

Conclusion

The study results shows trunk control and balance outcomes of adolescents with mildly affected hemiplegic CP were lower than their typically developing peers. In conclusion, it is thought that adding exercise programs that would improve trunk control and balance to the intervention programs of mildly affected adolescents with hemiplegic CP may contribute to the development of these adolescents. The study has provided guidance for clinicians and academics on the exercise program for adolescents with hemiplegic CP.

Funding

None declared.

Conflict of Interest

We have no conflict of interest related to this work.

H.Ü Sağlık Bilimleri Fakültesi Dergisi
Cilt: 12, Sayı: 1, 2025
Doi: 10.21020/husbfd.1507491

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