DOI: 10.24938/kutfd.1009538 Kırıkkale Üniversitesi Tıp Fakültesi Dergisi 2022;24(1):73-82
Original Article *Özgün Araştırma*

THE EVALUATION OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS LEVELS IN ADOLESCENT INDIVIDUALS WITH CEREBRAL PALSY

Adölesan Serebral Palsili Bireylerde Fiziksel Aktivite ve Fiziksel Uygunluk Seviyelerinin Değerlendirilmesi

Hanifi EROL [1], Meral SERTEL [2], Ayşegül ALPCAN [3], Mutluay ARSLAN [4]

[1] *Ankara City Hospital, Physiotherapy and Rehabilitation Department, ANKARA, TÜRKİYE*
[2] *Kırıkkale University, Health Sciences Faculty, Dept. of Physiotherapy and Rehabilitation, KIRIKKALE, TÜRKİYE*
[3] *Kırıkkale University, Faculty of Medicine, Pediatrics Department, KIRIKKALE, TÜRKİYE*
[4] *Health Sciences University, Gülhane Medical Faculty, Pediatric Neurology Department, ANKARA, TÜRKİYE*

ABSTRACT

Objective: This study aimed to evaluate physical activity and physical fitness in adolescents with cerebral palsy.

Material and Methods: Forty individuals (20 cerebral palsy and 20 asymptomatic adolescents) were included in the study. Physical activity levels were measured by Physical Activity Questionnaire for Adolescents; balance, agility, flexibility and arm movement speed, which are physical fitness parameters, were evaluated with Eurofit test battery; lower extremity muscle strength was evaluated with Muscle Force Evaluation Form; functional independence in the quality of life the individuals was evaluated with Functional Independence Measurement scales and cardiopulmonary endurance was assessed by 6-minute walking test.

Results: In statistical analysis, there was no significant difference between two groups for the assessment of agility, 6-minute walk test, flexibility, arm movement speed, balance. There was a significant difference in physical activity and functional independence in favor of asymptomatic group.

Conclusion: As a result of our study, it was determined that the levels of physical activity and physical fitness of the adolescents with cerebral palsy were lower. We believe that it is important to direct these individuals to sports and recreational activities, to increase their physical activity and fitness levels, and to reduce difference with their asymptomatic peers.

***Keywords**: Cerebral palsy, physical endurance, physical activity, physical fitness, quality of life.*

ÖZ

Amaç: Bu çalışmanın amacı, serebral palsili adölesan bireylerde fiziksel aktivite ve fiziksel uygunluk seviyelerinin değerlendirilmesidir.

Gereç ve Yöntemler: Kırk adölesan (20'si serebral palsili, 20'si sağlıklı adölesan) çalışmaya dahil edildi. Bireylerin fiziksel aktivitelerini değerlendirmek için Adölesan Fiziksel Aktivite Ölçeği; fiziksel uygunlukları değerlendirmek için Eurofit bataryasının ilgili parametrelerinin kullanıldığı sürat, esneklik ve denge değerlendirme formu; kardiyopulmoner enduransı değerlendirmek için 6 dakika yürüme testi; günlük yaşam aktivite bağımsızlığını değerlendirmek için Fonksiyonel Bağımsızlık Ölçütü ve alt ekstremite kas kuvvetini değerlendirmek için Kas Kuvveti Değerlendirme Formu kullanıldı.

Bulgular: Yapılan istatistiksel analizde; çeviklik, 6 dakika yürüme testi, esneklik, kol hareket hızı, denge değerlendirmesinde iki grup arasında anlamlı fark bulunmadı. Fiziksel aktivite ve fonksiyonel bağımsızlık açısından sağlıklı grup lehine anlamlı bir fark vardı.

Sonuç: Çalışmamız sonucunda serebral palsili adölesanların fiziksel aktivite ve fiziksel uygunluk seviyelerinin daha düşük olduğu tespit edildi. Bireylerin spor ve rekreasyonel aktivitelere yönlendirmenin önemli olduğu, bu sayede fiziksel aktivite ve uygunluk seviyelerinin artırılabileceğini ve sağlıklı akranlarıyla aradaki farkın azalacağını düşünüyoruz.

***Anahtar Kelimeler**: Serebral palsi, fiziksel dayanıklılık, fiziksel aktivite, fiziksel uygunluk, yaşam kalitesi.*

Correspondence / Yazışma Adresi: **Dr. Meral SERTEL**
Kırıkkale University, Health Sciences Faculty, Dept. of Physiotherapy and Rehabilitation, KIRIKKALE, TÜRKİYE
Phone / Tel: +90 535 5286059 **E-mail /** E-posta: fzt_meralaksehir@hotmail.com
Received / Geliş Tarihi: 14.10.2021 **Accepted /** Kabul Tarihi: 07.12.2021

KÜ Tıp Fak Derg 2022;24(1):73-82
Doi: 10.24938/kutfd.1009538

INTRODUCTION

Cerebral palsy (CP) is a condition which can affect the sense, perception, cognition, communication, behaviors with non-progressive posture and motion disorders of the fetal brain or infant's brain. The problems in musculoskeletal system like spasticity, dyskinesia, hyperreflexia, excessive coactivation of the antagonist muscles in individuals with CP could trigger other problems which occur in the functional activities like in motor control, walking and grip (1).

Physical activity is defined as any body movements that result in energy consumption in everyday life (2). Increase in activity has beneficial effects such as cardiorespiratory fitness, muscle strength, endurance and decrease in body fat. In the psychosocial benefits, there are decreases in anxiety and depression, increases in quality of life and self-confidence development (3). Individuals with CP avoid participating in physical activity since they face many problems causing limitations in their daily life activities. However, to avoid the harmful consequences of the cardiovascular and metabolic problems in adulthood, it is important to determine physical activity and fitness levels in individuals with CP to change behaviors in the early stages (4).

As adolescents with CP have low cardiorespiratory fitness levels and widespread muscle weakness (5), research on estimating their physical fitness levels and improving their daily functioning is important for therapists and researchers (6,7). People with CP spend more energy in exercise and physical activity than normal individuals. Equipment aggravates this situation. This may be important in terms of fatigue, decreased motivation and increased cardiac load (8,9).

Moreover, current data on anaerobic tests and training for adolescents with CP are inadequate as movements in childhood mostly include short-term high-intensity activity explosions and then short-term resting periods (10). Although CP is an area in which physiotherapists play an effective role, it was noteworthy that few studies were conducted especially in the adolescent age group. With this study, we think that more specific approaches are important in areas such as physical activity and functional independence in adolescents with CP, and that the results of our study will be a reference value for future studies. Therefore, this study aimed to examine physical fitness and physical activity in adolescents with CP.

MATERIALS AND METHODS

Participants

Forty individuals were included in the study. The study was carried out between November 2018 and May 2019. The World Health Organization has defined the age range of 10-19 as the adolescent period (11). Therefore, 20 participants, aged between 10 and 18, who were enrolled in the study had adolescent hemiparetic and diparetic CP. Twenty adolescents without any motor impairment who were the relatives of the patients coming to Special Education and Rehabilitation Center in Turkey were also included in the study. Power analysis was performed to determine the sample size to be included in the study. G* Power (version 3.1.9.2) package program was used for power analysis. As a result of the power analysis performed in this study, the effect size between the two groups with at least 40 adolescents (2 groups of at least 20 people) with 95% confidence level(with 0.05 margin of error) and 90% power analysis the effect size was found to be large (d:0.9).

The inclusion criteria for the individuals with CP were having diagnosed with hemiparetic or diparetic CP, being between the ages of 10 and 18, being Level 1 or 2 according to the Gross Motor Function Classification System (GMFCS), and cooperation for independent walking and evaluation without orthotics-orthosis. The inclusion criteria for the adolescents without motor impairments were being between the ages of 10 and 18,

KÜ Tıp Fak Derg 2022;24(1):73-82
Doi: 10.24938/kutfd.1009538

volunteering, not having any mental, orthopedic, neurological problems, and being able to communicate for evaluation. The individuals who had joint contractures, whose spasticity levels were bigger than 3 according to the Modified Ashworth Scale, those who were injected with botulinum toxin in the last six months, and individuals with any cardiopulmonary or systemic disorders were excluded from the study.

Ethics

The study was approved by the Kırıkkale University Ethics Committee of Non-interventional Research (date: 24/10/2018; issue number: 2018.10.11). Each individual was informed about the method and purpose of the study; and informed consent forms were received from the individuals who were 18 years and older. For the individuals who were under 18 years of age, these forms were signed by their parents of first degree showing that every individual participated voluntarily in the study. This study was performed in accordance with the Helsinki Declaration Principles. In addition, this study was based on a thesis project.

Measuring Tools

The ages, genders, weights, heights, body mass indices, education level, health insurance type, birth etiologies, and number of brother or sister were questioned to determine the sociodemographic characteristics of all individuals. In addition, the use of orthesis, accompanying problems, and status of receiving special and formal education were evaluated for individuals with CP. The GMFCS was used to determine the level of motor function of the individuals with CP while the Adolescent Physical Activity Scale (PAQ-A) was used to evaluate the physical activity levels of all individuals. The physical fitness was evaluated with the Speed, Flexibility and Balance Assessment Form in which were the relevant parameters of the Eurofit Battery. Cardiopulmonary endurance was evaluated with 6-minute walking test (6MWT) while the daily life activity independence was evaluated with the Functional Independence Measurement Scale (FIM), and lower extremity muscle strength was evaluated with Muscle Force Evaluation Form.

GMFCS is based on the actions started by the child, and emphasizes sitting, displacement, and mobility. The main criterion in the 5-level classification system is that the differences between the levels are significant in daily life (12).

PAQ-A is a scale used to remind the activities carried out in the last 7 days. It gives an idea of the participants about general physical activity habits within 24 hours (13). Its validity and reliability in Turkish were tested by Tanir et al (13).

For balance, a 50-cm long, 4-cm high and 3-cm wide metal or wooden beam was used in the Flamingo Balance Test. During this test, the subject tried to stand on the long axis of the beam for as long as possible, which is similar to a Flamingo stance. The disruptions in the balance in 1 minute were counted. In case there were more than 15 losses of balance in the first 30 seconds, the test was ended, and zero point was given to the subject. It is a valid and reliable test which is used in Turkey (14).

In measuring the arm movement speed (Plate Tapping), the individual tried to touch 2 discs quickly with the self-selected hand. Two 20-cm diameter plastic discs were lined up on a table. The distance of the two discs to each other from the central point was 80 cm (the edges with 60 cm distance). The 30 x 20 cm rectangular plate was placed on a place that was equal to two discs. The best score was recorded as the result. The score was recorded as the time that passed to touch each disc for 25 times (50 contacts) and as the decimal of a second (14).

For flexibility, the Sit-and-Stretch Test was used. The subject sat in front of a 35-cm long, 45-cm wide and 32-cm high box. After resting the feet on the inner side of the box, the subject tried to reach out three times with both hands, and the average of 3 values was recorded (14).

KÜ Tıp Fak Derg 2022;24(1):73-82
Doi: 10.24938/kutfd.1009538

To measure the speed of running, 10x5 Shuttle Run and cones or lines that were 5 meters apart from each other were prepared. The subject stood behind the start line. With the "Start" command, the subject ran with both feet across the two lines as fast as possible, crossing the opposite line, and returning to the start line. The subject repeated it 10 times until a total of 50 meters, and the running time was recorded (14).

In the 6MWT, the subject was asked to walk quickly without running between the "Start" and "Stop" commands in a 30-m corridor; and the distance taken in six minutes was measured (15).

FIM is a scale that assesses the performance of people in their daily life activities. The adaptation, validity and reliability studies of the scale to the Turkish population was carried out (16). The functional muscle strength of the lower extremity was measured with the 30s Repetition Maximum test. In this test, the child did three closed kinetic chain exercises. These were "lateral step up", "sit to stand" and "attain stand through half knee"; and were tested by looking at the maximum number of repetitions the child did in 30 seconds. It is a valid and reliable method for children with CP (17).

Statistical Method

The data were analyzed with the IBM SPSS Version 21.0 (SPSS, Chicago, IL). The continuous data was presented as mean ±standard deviation (M±SD) or median (minimum- maximum) and the categorical data were given as frequency and percentage (%). The fitness of the variables to normal distribution was analysed with the Shapiro-Wilk Test. Bonferroni Corrected Mann Whitney U Test was used for pairwise differences since nonparametric test assumptions were provided. A ***p*** value<0.05 was considered statistically significant in all analyses.

RESULTS

Demographics of adolescents were found to be similar (p>0.05) (Table 1). When the CP group was examined, in the majority of adolescents, it was seen that the birth occurred on time. It was observed that most families did not have intermarriage. Spasticity findings were detected in all the adolescents with CP who were included in the study. The use of orthosis was also seen in most adolescents with CP. The most common problem among the concomitant problems was vision problems (Table 2).

Table 1: Demographic information about age, height, weight and BMI of adolescents

	Group	**n**	**Median (min-max)**	**p**
Age, year	CP group	20	15 (10 -18)	0.557
	Asymptomatic group	20	14 (10-18)	
Height (cm)	CP group	20	153 (130- 176)	0.579
	Asymptomatic group	20	155 (134- 169)	
Weight (kg)	CP group	20	54.5 (28- 90)	0.297
	Asymptomatic group	20	55 (42- 72)	
BMI (kg/m^2)	CP group	20	21.87 (15.31 – 29.39)	0.122
	Asymptomatic group	20	23.91 (18.80 – 27.65)	

*p<0,05 Statistically Significant Difference -Mann Whitney-U Test; SD: Standard Deviation; Min: Minimum; Max: Maximum; BMI: Body Mass Index; CP: Cerebral palsy

Table 2: Descriptive demographic information of adolescents in CP Group

		n	**%**
Reasons of CP	Prenatal	7	35
	Natal	12	60
	Postnatal	1	5
Intermarriage	No	4	20
	Yes	16	80
Number of brother or sister	1	7	35
	2	8	40
	3	5	25
Sign of spasticity	Yes	20	100
	No	0	0
Orthosis use	Yes	13	65
	No	7	35
Accompanying problems	Impaired vision	5	25
	Hearing loss	1	5
	Speech disorders	2	10
	Epilepsy	1	5
	Dental problems	2	10
	No accompanying problem	8	40
	Hearing and vision problems	1	5
Type of CP	Hemiplegia	11	55
	Diplegia	9	45
Primary caregiver	Mother	17	85
	Father	3	15
Education level of primary caregiver	Literacy	1	5
	Primary School	7	35
	Middle School	5	25
	High School	4	20
	University	3	15
Marital status of caregiver	Married	20	100
	Single	0	0
Working condition of caregiver	Working	7	35
	Not Working	13	65
Location	Urban Area	20	100
	Rural Area	0	0

CP: Cerebral palsy

Table 3: Physical fitness assessment, PAQ-A and FIM test results

	Groups	Median (min-max)	p
6-Minute Walking Test (m)	CP group Asymptomatic group	491.5 (210-678) 674 (630-733)	**0.000**
Eurofit Flamingo Balance Test (sec) (Right)	CP group Asymptomatic group	13.5 (0-26) 0 (0-3)	**0.000**
Eurofit Flamingo Balance Test (sec) (left)	CP group Asymptomatic group	7.5 (0-26) 0 (0-2)	**0.000**
Plate Tapping Test (Right) (sec)	CP group Asymptomatic group	24.62 (13,7-39) 13.95 (11.2-18.6)	**0.000**
Plate Tapping Test (Left) (sec)	CP group Asymptomatic Group	24.35 (15-60) 14.35 (12.1-18)	**0.000**
10x5 M Shuttle Running Test (sec)	CP group Asymptomatic group	31.45 (21.65-118) 27.95 (23.9-35.2)	0.133
Flexibility Test (cm)	CP group Asymptomatic group	-6 (-29-12) 4 (-18-12)	**0.005**
Lateral Step Up (Right)	CP group Asymptomatic group	21.5 (6-33) 36 (25-42)	**0.000**
Lateral Step Up (Left)	CP group Asymptomatic group	23 (10-34) 35 (25-42)	**0.000**
Sit to Stand	CP group Asymptomatic group	15.5 (5-25) 20.5 (14-27)	**0.001**
Attain Stand Through Half Knee (Right)	CP group Asymptomatic group	11.5 (3-21) 21.5 (15-29)	**0.000**
PAQ-A Test Score	CP group Asymptomatic group	2.3 (1.13-3.86) 3.27 (2.19-4.1)	**0.000**
FIM Test Score	CP group Asymptomatic group	120 (110-125) 126 (126-126)	**0.000**

Mann Whitney-U Test; PAQ-A: Physical Activity Scale; FIM: Independence Measurement Scale; SD: Standard Deviation; Min: Minimum; Max: Maximum

When the clinical CP types of the adolescents were examined, it was seen that the number of hemiparetic and diparetic types were close to each other. It was determined that the primary caregivers were mostly mothers; and all were married. It was also determined that the caregivers mostly did not work, and all of them lived in the city centers (Table 2).

The data on the physical fitness evaluations of the groups is given in Table 3. Statistically significant differences were detected between the adolescents at 6MWT distances ($p<0.05$).

The results of the Flamingo Test, Disc Touch Test, and Flexibility Test, which are among Eurofit Evaluation Parameters, had statistically significant differences between the groups ($p<0.05$); however, there were no statistically significant differences in 10x5 Shuttle Running Test results ($p>0.05$). In Lateral Step Up, Sit to Stand, and Attain Stand Through Half Knee evaluations, which included functional muscle strength measurement

KÜ Tıp Fak Derg 2022;24(1):73-82
Doi: 10.24938/kutfd.1009538

data, statistically significant differences were detected between the groups ($p<0.05$) (Table 3).

A statistically significant difference was detected between the two groups in the PAQ-A Physical Activity Questionnaire scores ($p<0.05$). The FIM scores were also different at statistically significant levels in both groups ($p<0.05$). All the adolescents in the asymptomatic group were found to receive full points in the FIM Questionnaire (Table 3).

DISCUSSION

Our study was planned to evaluate the physical activity and physical fitness levels of adolescents with CP. It was determined that the physical activity and fitness levels of the adolescents with CP are lower than their asymptomatic peers.

As the age increases in CP, the frequency of orthopedic or neurological problems increases (18). Because of motor problems, the individuals with CP experience social participation and physical activity limitations (19). The individuals with CP show lower physical activity levels than their asymptomatic peers. Low physical activity levels lead to reduced physical fitness (20). In a study conducted by Carlon et al., it was determined that young people with CP participated in 13% to 53% less physical activity than their asymptomatic peers. As a result, it was found that the adolescents with CP had significantly lower physical activity levels compared to their peers. For this reason, it was reported that they are likely to face negative results like metabolic dysfunctions because of immobility, cardiovascular diseases, and low bone density (21). As a result of the study conducted by Maher et al., in which they evaluated the physical activity of the individuals with CP and asymptomatic adolescents, it was reported that adolescents with CP were less active, their physical activity scores were inversely proportional to their ages (22).

In our PAQ-A evaluation results, it was found that asymptomatic adolescents were physically more active, which is in line with the literature data (23). Since physical activity is important, it is important that adolescents with CP are encouraged to participate in sports to increase their general endurances. We believe that appropriate programs should be organized and enabled in adolescents with CP to increase their physical activity levels. In this way, we believe that adolescents with CP will be more independent in their daily life activities, and become enabled to do their own work more confidently.

In El et al.'s study, which included 20 hemiparetic CP and 20 asymptomatic adolescents, they evaluated Cardiorespiratory Endurance with 6MWT, Flexibility with Sit-and-Stretch Test, and independent daily life activities with WeeFIM (24). The results of the group with CP were found to be lower than the asymptomatic group. It was found that CP influenced cardiorespiratory status, and this prevented the physical, mental and social development of children, decreasing their quality of life (24).

In the study conducted by Akınoğlu and Köse to determine the physical fitness in children with CP, 20 hemiparetic, 20 diparetic, and 22 adolescents without motor impairments were included. 6MWT was used for cardiorespiratory fitness, Sit-and-Stretch Test was used for flexibility, and 10x5 Shuttle Running Test was used for agility. Although no significant differences were detected in the flexibility between the groups, there was a significant difference between agility and distances in 6MWT in this study (25). In our study, the results were similar in 6MWT distance results for similar average age which supports the literature (26). As a result of our study, when the 6-minute walking distances were examined, it was determined that individuals with CP had less walking distances than adolescents without motor impairments. We believe that the presence of low cardiorespiratory fitness levels and common muscle weakness in adolescent individuals with CP might have

KÜ Tıp Fak Derg 2022;24(1):73-82
Doi: 10.24938/kutfd.1009538

caused this. However, in our study, no significant differences were detected between the two groups in the results of the 10x5 Shuttle Running Test, which was used to compare the agility status. The average duration of this test was 41.31 seconds in the CP group, while it was 28.28 seconds in the asymptomatic group. Although it was not statistically significant, asymptomatic adolescents completed this test in a shorter period of time. We believe that the agility parameters must be evaluated in detail in future studies.

In the study conducted by Garcia et al., 40 CP and 40 asymptomatic individuals were included, and the parameters like cardiorespiratory fitness, agility, and flexibility were evaluated. As a result of the study, it was determined that the individuals with CP were underperforming in most of the cardiorespiratory metabolic tests (27). Similar to our study, the sit-out flexibility test evaluation results were found to be lower in the CP group than in the asymptomatic group. This gives us the need to identify the specific fitness skills of the individuals better, and shows us that it is important to develop targeted physiotherapy programs for functional fitness and to direct individuals to physical activity and sports.

One of the most fundamental deficiencies of the individuals who have CP is poor posture control. The disorders in the body must be evaluated, and functional performance must be increased to maintain control (28). In a study that was conducted by Özal and Günel with 19 CP children between the ages of 5 and 17, it was found that the limitations in the posture control and balance in children with CP caused limitations in the performance of voluntary skills, which include mobility abilities (29).

In a study that was conducted by Panibatla et al., 24 CP individuals who were between the ages of 8 and 14, it was found that the body control and balance showed different effects depending on the gender and the severity of motor disorders. A positive and high correlation was detected between the body control and balance in individuals with spastic CP (28). In a study that was conducted by Gillett et al., the lower extremity muscle strength and functional capacity were evaluated in 33 individuals with CP between the ages of 15 and 51. At the end of the study, it was reported that the low isometric plantar flexion force was associated with 6MWT, lateral step up, and low values in ladder performance test. It was emphasized that low isometric muscle strength caused a decrease in the functional capacity of the individuals with CP (30).

In our study, a significant difference was detected in the Flamingo Balance Test in favor of the asymptomatic group. It was determined that the individuals with CP had balance problems, and their static balance was weak. In the functional muscle strength evaluations, it was observed that the group with CP had lower scores in the lateral step up, sit to stand, and attain stand through half knee. In light of these data, it was concluded that the individuals with CP had difficulty in performing the functional activities in everyday life, and needed longer times to complete the movements. With this study, we think that more specific approaches are important in areas such as physical activity and functional independence in adolescents with CP, and that the results of our study will be a reference value for future studies. We believe that, with studies evaluating cerebral palsy subtypes in detail, especially in adolescents with cerebral palsy, individuals with cerebral palsy will be more functionally independent and the difference between them and their healthy peers will be minimized by supporting the deficiencies that arise as a result of the incorrect determination of physical fitness and activity levels in the period from infancy to adulthood.

As a result of our study, it was determined that the levels of physical activity and physical fitness of the adolescents with CP were lower. We believe that it is important to direct these individuals to sports and recreational activities, to increase their physical activity and fitness levels, and to reduce the difference with their asymptomatic peers.

Conflicting of interests: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author Contributions: Concept/Planning: HE, MS; Analysis/Interpretation: HE, MS, AA, MA; Data Collection: HE, AA, MA; Writer: HE, MS; Review and Revision: HE, MS; Confirmation: HE, MS, AA, MA.

Support and Acknowledgements: The authors aren't disclosed receipt financial support for the research, authorship, and/or publication of this article.

Ethical Committee Approval: Kırıkkale University Ethics Committee of Non-interventional Research, date: 24.10.2018; issue number: 2018.10.11.

REFERENCES

1. Strauss D, Shavelle R, Reynolds R, Rosenbloom L, Day S. Survival in cerebral palsy in the last 20 years: signs of improvement. Developmental Medicine & Child Neurology. 2007;49(2):86-92.
2. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-131.
3. Conchar L, Bantjes J, Swartz L, Derman W. Barriers and facilitators to participation in physical activity: The experiences of a group of South African adolescents with cerebral palsy. J Health Psychol. 2016;21(2):152-63.
4. Fowler EG, Kolobe TH, Damiano DL, Thorpe DE, Morgan DW, Brunstrom JE et al. Promotion of physical fitness and prevention of secondary conditions for children with cerebral palsy: section on pediatrics research summit proceedings. Phys Ther. 2007;87(11):1495-510.
5. MacPhail HA, Kramer JF. Effect of isokinetic strength-training on functional ability and walking efficiency in adolescents with cerebral palsy. Developmental Medicine & Child Neurology. 1995;37(9):763-75.
6. Hoofwijk M, Unnithan V, Bar-Or O. Maximal treadmill performance of children with cerebral palsy. Pediatr Exerc Sci. 1995;7(3):305-13.
7. Unnithan VB, Dowling JJ, Frost G, Bar-Or O. Role of co-contraction in the O2 cost of walking in children with cerebral palsy. Med Sci Sports Exerc. 1996;28(12):1498-504.
8. Verschuren O, Ketelaar M, Takken T, Helders PJ, Gorter JW. Exercise programs for children with cerebral palsy: a systematic review of the literature. Am J Phys Med Rehabil. 2008;87(5):404-17.
9. Verschuren O, Ada L, Maltais DB, Gorter JW, Scianni A, Ketelaar M. Muscle strengthening in children and adolescents with spastic cerebral palsy: considerations for future resistance training protocols. Phys Ther. 2011;91(7):1130-9.
10. Bailey RC, Olson J, Pepper SL, Porszasz J, Barstow TJ, Cooper DM. The level and tempo of children's physical activities: an observational study. Med Sci Sports Exerc. 1995;27(7):1033-41.
11. Naçar M, Günay O. Adolesan Sağlığı. In: Öztürk Y, Günay O, eds. Halk Sağlığı Genel Bilgiler. Kayseri. Erciyes Üniversitesi Yayınları, Önder Ofset, 2011:711-746.
12. Palisano RJ, Rosenbaum P, Bartlett D, Livingston MH. Content validity of the expanded and revised Gross Motor Function Classification System. Developmental Medicine & Child Neurology. 2008;50(10):744-50.
13. Tanir H. The effect of physical activity level and certain anthropometric characteristics on academic achievement among the pupils at grade eight in primary schools. Unpublished doctoral thesis. Kırıkkale University, Institute of Health Sciences, Kırıkkale.2013.
14. Erikoğlu Ö, Atalay Güzel N, Pense M, Erikoğlu Örer G. Comparison of physical fitness parameters with

EUROFIT Test Battery of male adolescent soccer players and sedentary counterparts. International Journal of Science Culture and Sport. 2015;3(3):43-52.

15. Leunkeu AN, Shephard RJ, Ahmaidi S. Six-minute walk test in children with cerebral palsy gross motor function classification system levels I and II: reproducibility, validity, and training effects. Arch Phys Med Rehabil. 2012;93(12):2333-2339.
16. Kucukdeveci AA, Yavuzer G, Elhan AH, Sonel B, Tennant A. Adaptation of the Functional Independence Measure for use in Turkey. Clin Rehabil. 2001;15:311-319.
17. Verschuren O, Ketelaar M, Takken T, Van Brussel M, Helders PJ, Gorter JW. Reliability of hand-held dynamometry and functional strength tests for the lower extremity in children with cerebral palsy. Disability and Rehabilitation. 2008;30(18):1358-1366.
18. Morris C, Newdick H, Johnson A. Variations in the orthotic management of cerebral palsy. Child: Care, Health and Development. 2002;28(2):139-147.
19. Sahoo R, Rege S, RaoSocial S. Participation in Children with Cerebral Palsy. Online J Health Allied Sci. 2017;16(4):1-4.
20. Claassen AA, Gorter JW, Stewart D, Verschuren O, Galuppi BE, Shimmell LJ. Becoming and staying physically active in adolescents with cerebral palsy: protocol of a qualitative study of facilitators and barriers to physical activity. BMC Pediatrics. 2011;11(1):1-11.
21. Carlon SL, Taylor NF, Dodd KJ, Shields N. Differences in habitual physical activity levels of young people with cerebral palsy and their typically developing peers: a systematic review. Disability and Rehabilitation. 2013;35(8):647-55.
22. Maher CA, Williams MT, Olds T, Lane AE. Physical and sedentary activity in adolescents with cerebral palsy. Dev Med Child Neurol. 2007;49(6):450-457.
23. Telford DM, Signal DM, Hofman PL, Gusso S. Physical activity in adolescents with and without type 1 diabetes during the New Zealand COVID-19 pandemic lockdown of 2020. Int J Environ Res Public Health. 2021;18(9):4475.
24. El C, Huzmeli I, Dogru Huzmeli E, Duman F. Evaluation of cardiorespiratory state in patients with cerebral palsy. Ann Med Res. 2019;26(3):447-451.
25. Akınoğlu B, Nezire K. Hemiparetik ve diparetik serebral paralizili çocuklarda fiziksel uygunluk düzeyinin belirlenmesi. Fizyoterapi Rehabilitasyon. 2018;29(1):11-18.
26. Ulrich S, Hildenbrand FF, Treder U, Fischler M, Keusch S, Speich R et al. Reference values for the 6-minute walk test in healthy children and adolescents in Switzerland. BMC Pulmonary Medicine. 2013;13(1):49.
27. García CC, Alcocer-Gamboa A, Ruiz MP, Caballero IM, Faigenbaum AD, Esteve-Lanao J et al. Metabolic, cardiorespiratory, and neuromuscular fitness performance in children with cerebral palsy: a comparison with healthy youth. J Exerc Rehabil. 2016;12(2):124-131.
28. Panibatla S, Kumar V, Narayan A. Relationship between trunk control and balance in children with spastic cerebral palsy: a cross-sectional study. J Clin Diagn Res. 2017;11(9):05-8.
29. Özal C, Günel MK. Spastik serebral palsili çocuklarda gövde kontrolü ile fonksiyonel mobilite ve denge arasındaki ilişkinin incelenmesi. Journal of Exercise Therapy and Rehabilitation. 2014;1(1):01-8.
30. Gillett JG, Lichtwark GA, Boyd RN, Barber LA. Functional capacity in adults with cerebral palsy: lower limb muscle strength matters. Arch Phys Med Rehabil. 2018;99(5):900-906.