The effects of an eight-week multi-model sport activity home programme on function of children with cerebral palsy

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Summary

Study aim: This study was performed to investigate the effects of an eight-week multi-model sport activity home programme on function of children with cerebral palsy.

Material and methods: The study included 44 patients (11 girls, and 33 boys) aged between 4 and 11 years, having spastic diplegic and hemiplegic cerebral palsy, and receiving physical treatment from the rehabilitation centre. The 44 patients were divided into two groups each consisting of 22 children as the experimental group and control group. The mean age, height and weight were 8.27 ± 2.10 years, 123.36 ± 17.33 cm and 25.45 ± 8.87 kg in the experimental group, while the same parameters were 7.27 ± 2.80 years, 109.36 ± 16.99 cm and 20.20 ± 7.16 kg in the control group. Before taking measurements, the consent forms were signed by the families of patients with CP. The physical therapy programme based on the Bobath NDT method which took forty minutes was applied to both groups two days per week. Also, the multi-model sport activity home programme which took 50 minutes was applied regularly during eight weeks and five days a week in the Experimental Group. The Impact on Family Scale, the Gross Motor Function Classification System, the Gross Motor Function Measure, One Minute Walk Test, the time standing on the left and right foot, and Visual Pain Analog Scale were evaluated before and after the eight-week multi-model sport activity home programme.

Results: There were no significant differences in some measurements including the Gross Motor Function Classification System, the Gross Motor Function Measure, One Minute Walk Test, and the time standing on the left and right foot. A significant difference was found only in the Visual Pain Analog Scale ($p = 0.003$).

Conclusion: The effects of the eight-week multi-model sport activity home programme can contribute to a decrease in pain level of children with cerebral palsy.

Key words: Home exercise programme – Cerebral palsy – Sports activities

Introduction

Cerebral palsy (CP) defines a group of permanent disorders that leads to disruption in development of movement and posture, causing activity limitation. These are referred to as non-progressive disturbances that occurred in the developing fetal or infant brain and are associated with pain. The motor disorders are often accompanied by disturbances of sensation, perception, cognition, communication, and behaviour, epilepsy, and secondary musculoskeletal problems [21, 29, 31]. Also, CP is characterized by problems such as motor and postural impairment, delayed onset of movement, difficulty in maintaining posture against gravity and inability to adjust postural activity

[19, 28, 29]. The incidence of CP was reported as 2–5 per 1000 live births in developed countries, whereas the CP prevalence was 4.4 per 1000 live births in Turkey [7, 13, 19, 20, 28]. Spastic hemiplegia, diplegia, and quadriplegia were the most frequent types of CP [4, 13]. CP rehabilitation is sophisticated and difficult/exhausting, as well as a long lasting occupation. The family is the most important element of CP rehabilitation. Physiotherapy and exercise programmes are necessary to be practised and adopted lifelong by children. The Bobath Neurodevelopmental Treatment (NDT) has been used most [19]. Children with CP have difficulty in begin and maintain physically active. Subjects with CP strive to continue function and flexibility, and to perform activities of daily living. Physical therapy plays an important role in CP treatment. However,

few scientific findings exist to prove the efficacy and guide treatment [5]. There are some studies about various exercise programmes used in CP rehabilitation including sports activity as an alternative to classic physical therapy, cardiorespiratory endurance training, and muscle strengthening training programmes [5, 6, 12, 30]. Verschuren et al. reported that children with CP benefit from especially lower extremity muscle strengthening and an exercise programme consisting of cardiorespiratory fitness [30].

Also, home-based strengthening training in combination with traditional strategies can enhance the motor activity including walking, running, jumping, and stair climbing without an adverse impact [6]. Carroll et al. reported that sport could be beneficial in performing as practical. For this reason, sport was an important part of CP treatment, and sports activities including swimming, basketball, bowling, and cycling present an enjoyable alternative, providing skills to children with CP for life-long activity. Additionally, the sport is a natural extension of activity [5]. In a that study investigated the effects of sports activities on patients with CP, it was reported that Wii Sports, tennis, and boxing were useful as treatment to provide healthy life and activity level in CP children having Gross Motor Function Classification System (GMFCS) level 1 and 2 [12]. Sports activities usually are done in a gym, or outdoor space. However, there are few opportunities for patients with CP to do sports in outdoor space alone. Bobath NDT is sometimes considered to be boring and challenging by patients with CP. Also, these activities are performed by parents, or other practitioners. For this reason, the children with CP remain passive. The sports activities give an opportunity to children with CP to perform independently and also remain more active. In the light of all information, both Bobath NDT and various exercise programmes such as strengthening or stretching are used in CP rehabilitation commonly.

We could not find any study in which both Bobath NDT programme and sports activities were performed in combination. Additionally, we wanted to assess whether or not sport activities can be an integral part of medical therapy in the early period of CP. In this context, the aim of this study was to investigate the effects of an eight-week multi-model home sport activity programme on function of children with cerebral palsy.

Materials and methods

Participants

The patients, aged between 4 and 11 years, had diplegia and hemiplegia types of CPs, and were receiving physical treatment from the rehabilitation centre. 44 patients (11 girls, and 33 boys) with CP were included in our study. 44 patients were divided into two groups each consisting

of 22 children as the Experimental Group (EG) and Control Group (CG). In EG and CG, there were 30 diplegia CP and 14 hemiplegia CP (17 diplegia and 5 hemiplegia in EG; 13 diplegia and 9 hemiplegia in CG). 7 subjects in EG, and 8 subjects in CG walked with aids including sticks or a walker (GMFCS III). Also, 8 subjects in EG, and 8 subjects in CG walked most settings but with aids in the community (GMFCS II). 7 subjects in EG, and 6 subjects in CG walked every setting (GMFCS I).

Inclusion criteria for this study were:

- (1) To be diagnosed with hemiplegia or diplegia CP;
- (2) Absence of any history of intellectual disability, visual and hearing impairment, and epilepsy;
- (3) Subjects standing with support or unsupported, and between level I and level III according to GMFCS.

Exclusion criteria for this study were:

- (1) Subjects having no spasticity degree 1+ and above according to Modified Ashworth Scale;
- (2) Subjects who did not participate in the study one week or over;
- (3) Subjects between level IV and level V according to GMFCS.

Testing procedure

The study protocol was approved by the Ethics Committee of Cukurova University. Before taking measurements, the voluntary consent forms were signed by the families of patients with CP. A physical therapy programme based on the Bobath NDT method which took forty minutes was applied by the same physiotherapist to both groups on two days a week during eight weeks. Also, the multi-model home exercise programme supported with sports activities which took 50 minutes was applied regularly to the Experimental Group for eight weeks and five days a week. In addition to the Bobath NDT, this programme was shown to the parents of patients with CP and an exercise programme brochure was prepared. They were asked to implement this exercise programme as a home programme. The home programme based sports activities was checked by a practitioner with an exercise attendance schedule. Moreover, the evaluation design consisted of demographic data, the Impact on Family Scale, Gross Motor Function Classification System (GMFCS), Gross Motor Function Measurement (GMFM), One Minute Walk Test, the time standing on the right and left foot, and the Visual Analog Scale (VAS). All measurements were applied twice to participants and the best measurement value was recorded.

These tests were as follows:

Gross Motor Function Classification System (GMFCS):

The GMFCS was designed for children with CP twelve years of age or younger. The system has five levels that are based on differences in self-initiated movement, with particular emphasis on sitting and walking [2, 8, 9, 16, 22].

GMFCS level I may be defined as walking without restrictions; limitations in more advanced gross motor skills.

GMFCS level II may be defined as walking without assistive devices; limitations walking outdoors and in the community.

GMFCS level III may be defined as walking with assistive mobility devices; limitations walking outdoors and in the community.

GMFCS level IV may be defined as self-mobility with limitations; children are transported or use power mobility outdoors and in the community.

GMFCS level V may be defined as self-mobility being severely limited even with the use of assistive technology [2, 22].

Gross Motor Function Measurement (GMFM): The GMFM is a criterion-based observational measure constructed for the purpose of evaluation of change in gross motor function in children with CP. The GMFM consists of 88 items grouped in five dimensions: (1) lying and rolling (17 items), (2) sitting (20 items), (3) crawling and kneeling (14 items), (4) standing (13 items), and walking, running, and jumping (24 items). The GMFM takes approximately 45 minutes for the user [2, 8, 9, 16, 22].

The One Minute Walk Test was developed to evaluate the results and to assess the outcome of strengthening programmes in children and adults with CP by Andersson and Blundell in 2003. The test is included as a potential measure of functional ability and walking endurance [18]. Moreover, children wore their own shoes (walking aids or splints) and were asked to walk as fast as possible with their own rhythms for one minute. The subjects were allowed to walk on a flat surface of 30 meters. The distance was recorded in metres.

Visual Analog Pain Scale (VAS): The VAS is used to covert some non-quantifiable values into numeric values. The scale determines the subjective pain intensity. It is a 10-point millimetre numeric scale with 0 representing one pain extreme ("no pain") and 10 representing the other pain extreme ("pain as bad as you can imagine" and "worst pain imaginable). Also, the patient is asked to indicate where the patient's condition is on this line by drawing a line or by pointing. The length of the distance at the marked point on the line is measured and indicates the pain intensity of the patient [17].

The time standing on the right and left foot: The children with CP were asked to stand on the right and left foot, respectively. The standing time was recorded.

The Impact on Family Scale: The scale was developed by Stein and Riessman to measure the effect in patients having chronic disability. This scale consists of financial burden, familial and social impact, personal strain, and mastery. Minimum and maximum obtained scores are 24 and 96 points. The scale has a Likert type rating scale from 1 to 4. The higher the obtained score the stronger is the influence [3].

Multi-model home sport exercise programme

An eight-week multi-model home sport exercise programme was prepared by selecting from fundamental gymnastic sport activities, Gross motor function measure items according to disability level of participants. (Sport activity movements including basic gymnastic positions were used in our study.)

Warm-up exercise programme (10 minutes)

Stretching exercises such as plantar flexors, hip adduction, hip flexor, lumbar extensors, and hamstring muscle group, gait exercises such as march/step forward/lateral/backwards were performed.

Main period (30 minutes)

The basic gymnastic movement-exercise, and Gross Motor Function measure items were used in this period.

Straddle standing position feet apart, half squat back to wall, upright kneeling position, lunge forward (the front leg is bent and the back leg is straight), flamenco stand, supported candlestick stand, supported star, bridge (lie on your back with hands at her/his sides, knees bent, feet flat, he/she raises from floor), supported tuck; pedalling with feet in supine position; to draw eight figure with feet in standing position; reach forward with right/left arm hand above shoulder level respectively, reach backward with right/left leg above shoulder level respectively in crawling position; attains high knee using arms/arms free, attains half knee on right/left knee using arms/arm free in kneeling position; walk with knee forward and backward; lift left/right foot arms free or holding on to handle with one hand in standing position; holding (or not) on handle cruises 5 steps to right/left, walk forward 5 steps and stop, turn 180°, walk backward 5 steps, walk forward 5 sequential steps between parallel lines, walk forward 5 consecutive steps on a straight line, kick ball with right/left foot both sitting and standing position, heel-to toe walking, jumps forward as many as possible cm, jumps off, both feet; long sitting feet together knees and back straight; tailor sit; V sit both legs raised, feet at the chest level in sitting position.

Cool-down period exercise (10 minutes)

Stretching exercises such as plantar flexors, hip adduction, hip flexor stretching exercise, lumbar extensors, and hamstring muscle group were performed.

Results

Forty-four patients aged between 4 and 11 years were included in this study. Forty-four patients were divided into two groups. Each group consisted of 22 children as the Experimental Group (EG) and Control Group (CG). When

analysing groups' measurements for the pre-treatment period, a significant difference was not found between EG and CG in the parameters including GMFCS levels (0.931), VAS (0.701), One Minute Walk Test (0.985), GMFM (0.948), standing time on right foot (0.267); and standing time on left foot (0.958). These findings showed that the physical features of groups were similar in the pre-treatment period. Also, the independent sample t test was used to compare demographic data and the Impact on Family Scale of two groups, as shown in Tables 1–2. The Impact on Family Scale parameters including Financial Burden, $p = 0.733$; Familial and Social Impact, $p = 0.092$; Personal strain, $p = 0.193$; and Total Impact $p = 0.208$ were measured and there were no significant difference between groups. However, the Mastery parameter, $p = 0.004$ was higher in CG than in EG. Accordingly, the demographic features of EG's and CG's families were similar in the pre-treatment period. Chi Square Test were used in the distribution of the Gross Motor Function Classification System (GMFCS) measurement in Experimental and Control group and results of pre and post treatment are shown in Table 3. In addition, seven children (31.82%) were GMFCS level 1, eight children (36.36%) were GMFCS level 2 and seven children (31.82%) were GMFCS level 3 in EG.

Six children (27.28%) were at GMFCS level 1, eight children (36.36%) were at GMFCS level 2 and eight children (36.36%) were at GMFCS level 3 in the Control Group. There was no significant difference in pre-test GMFCS levels (0.931) between EG and CG. According to the post-test GMFCS result, there was no significant difference between EG and CG ($p > 0.05$). The fact that GMFCS levels remain the same can be considered as an indication that there is no regression in motor development. This suggests that the multi-model sport activity home programme may have a positive effect.

Also, there is no significant difference both in the Experimental Group (pre-test, 16.97 ± 8.90 ; post-test 17.00 ± 8.91) in the One Minute Walk Test parameter ($p > 0.05$) and in Control Group (pre-test, 16.93 ± 9.76 ; post-test, 16.94 ± 9.77). Additionally, statistically significant difference is not found between Experimental and Control groups at the end of 8 weeks ($p = 0.078$). Standing time on the right foot was measured as 1.38 ± 1.94 s (pre-test), 1.40 ± 1.96 s (post-test) in the Experimental Group ($p > 0.05$); whereas the same parameter was 0.81 ± 1.39 s (pre-test), 0.82 ± 1.40 s (post-test) in Control Group ($p > 0.05$). Standing time on the left foot was measured as 1.767 ± 2.86 s (pre-test), 1.774 ± 2.86 s (post-test) in

Table 1. The Comparison of the demographic features of Experimental and Control Group

Parameter	Groups	Mean (Min–Max)	Standard deviation	P
Age [year]	Experimental Group	8.27 (4–11)	2.10	0.190
	Control Group	7.27 (4–11)	2.80	
Height [cm]	Experimental Group	123.36 (89–163)	17.33	0.010
	Control Group	109.36 (89–156)	16.99	
Weight [kg]	Experimental Group	25.45 (14–42)	8.87	0.370
	Control Group	20.20 (12–42)	7.16	

Table 2. The Comparison of the Impact on Family Scale of Experimental and Control Group

Parameter	Groups	Mean	Standard deviation	P
Financial Burden	Experimental Group	10.09	1.80	0.733
	Control Group	9.91	1.72	
Familial and Social Impact	Experimental Group	27.59	4.18	0.092
	Control Group	25.54	3.67	
Personal strain	Experimental Group	32.73	4.27	0.193
	Control Group	31.09	3.93	
Mastery	Experimental Group	5.45	1.71	0.004
	Control Group	7.14	1.91	
Total impact	Experimental Group	60.32	7.52	0.208
	Control Group	57.54	6.84	

Table 3. The distribution of the Gross Motor Function Classification System (GMFCS) measurement in Experimental and Control Group

Test	Groups		Gross Motor Function Classification System (GMFCS)			Total
			Level 1	Level 2	Level 3	
Pre-test	Experimental Group	N	7	8	7	22
		Intragroup %	31.82%	36.36%	31.82%	100%
		Total %	15.91%	18.18%	15.91%	50%
	Control Group	N	6	8	8	22
		Intragroup %	27.28%	36.36%	36.36%	100%
		Total %	13.64%	18.18%	18.18%	50%
		X ² = 0.144			SD = 2	P = 0.931
		Level 1	Level 2	Level 3		
Post-test	Experimental Group	N	7	8	7	22
		Intragroup %	31.82%	36.36%	31.82%	100%
		Total %	15.91%	18.18%	15.91%	50%
	Control Group	N	6	8	8	22
		Intragroup %	27.28%	36.36%	36.36%	100%
		Total %	13.64%	18.18%	18.18%	50%

Table 4. The comparison of the test procedures of Experimental and Control Group

Parameter	Groups	Mean	SD	P
Pain level (pre-test)	Experimental Group	85.69	17.56	0.003
	Control Group	84.68	20.94	
Pain level (post-test)	Experimental Group	88.65	15.07	0.078
	Control Group	85.29	20.83	
Gross Motor Function Measurement (pre-test)	Experimental Group	72.29	12.87	0.098
	Control Group	72.11	10.91	
Gross Motor Function Measurement (post-test)	Experimental Group	72.46	12.90	0.725
	Control Group	72.17	10.97	
One minute walk test (pre-test) meter	Experimental Group	16.97	8.90	0.927
	Control Group	16.93	9.76	
One minute walk test (post-test) meter	Experimental Group	17.00	8.91	0.927
	Control Group	16.94	9.77	
Stand time on right foot (pre-test) meter	Experimental Group	1.38	1.94	0.927
	Control Group	0.81	1.39	
Stand time on right foot (post-test measurement) sec.	Experimental Group	1.40	1.96	0.927
	Control Group	0.82	1.40	
Stand time on left foot (pre-test) sec.	Experimental Group	1.767	2.861	0.927
	Control Group	1.722	2.736	
Stand time on left foot (post-test) sec.	Experimental Group	1.744	2.862	0.927
	Control Group	1.729	2.744	

the Experimental Group ($p > 0.05$); whereas the same parameter was 1.722 ± 2.736 s (pre-test), 1.729 ± 2.744 s (post-test) in Control Group ($p > 0.05$). There is no significant difference between groups at the end of eight week in standing time on the left foot ($p = 0.927$) and the right foot (0.725) (Table 4).

Discussion

It was reported that the term “cerebral palsy” was first used in the medical literature by William Osler in the article entitled “The Cerebral Palsies of Children” in 1889. William Osler coined the term to explain a group of children. William Osler had seen in his practice at the Philadelphia Infirmary for Nervous Diseases who resembled those reported previously by other physicians, and William Little in 1862. All of these children had an early onset of motor impairment that was attributed by both Little and Osler primarily to an acquired birth injury to the brain. Sigmund Freud in 1897 noted that the roots of monitored symptoms were more often prenatal period [3, 24, 26, 27]. In 2007 a consensus defined the term cerebral palsy as identifying a a group of permanent disorders of the development of movement and posture, causing activity limitation that is attributed to non-progressive disturbances that occurred in the developing fetal or infant brain [20, 27, 31]. The newest, more accurate, and beneficial term was accepted as cerebral palsy spectrum disorder [27]. Spastic CP is seen as the most prevalent (70% of cases). The spastic type CP often results in the development of contractures especially at the elbows, wrists, hips, knees and ankles. Spastic diplegia, which is usually associated with prematurity, is characterized by spasticity of both lower limbs with minimal upper extremity involvement, and spastic hemiplegia involvement is unilateral, with the upper limb usually being affected more than the lower limb, and is characterized by involvement of one side of the body, with the arm typically more affected than the leg [2, 13, 20]. The main source of the pain varies across ambulatory and non-ambulatory children. The cause of pain is reported as several factors including muscle weakness, fatigue, overuse, muscle spasm, abnormal gait pattern, falls, and fractures in ambulatory children, whereas hip dislocation, subluxation, dystonia, and constipation play a role in non-ambulatory children having pain. The back, hips, and lower extremities have been identified as consistent sources of pain in investigations on pain in adults with CP [24, 31]. Also, some of the pain sources were muscles, joints, skeleton and increased muscle tone (spasticity) [24, 31]. Musculoskeletal pain occurred in the back, neck, foot/ankle, shoulder, knee, hip and arm. These types of pain can be prevented with regular exercises. Exercise will provide strength. For this reason, pain will be decreased [31]. In our study, 79.54%

($n = 35$) of participants suffered from lower leg pain (calf muscles), 11.36% ($n = 5$) of participants suffered from foot pain and 9.09% ($n = 4$) of participants suffered from pain in other related regions (i.e. knee, hip, thigh, shoulder, and abdomen, respectively). Our study results showed that the exercise programme used by the Experimental Group (EG) positively affected pain of children with cerebral palsy. The main reason for the significant decrease in pain level in children with CP was thought to be the regular multi-model sport activity home programme. Additionally, the reason for the higher pain level in CG than in EG was thought to be sport activities performed for EG, because the multi-model sport activity home programme was done in the EG as well as the Bobath NDT. Children with CP in EG made the sports activities more controlled without exceeding the pain threshold. This can be based on the relaxing effect of sports activities. Symptoms vary from mild to severe depending on the location, degree and affected area of the CP. Although rehabilitation of CP varies according to clinical types, the NDT approach is the most commonly used treatment option [11, 16, 35]. The principal aim of NDT is to regulate the motor responses with the neural-based central nervous system. Exercises planned for children with CP are structural and planned activities involving repetitive movements of skeletal muscles and aim to improve or maintain the physical-functional level [11]. Also, the other aim is to gain normal postural muscle tone by reducing excessive muscle tone and preventing muscle fluctuation [16]. It was reported that there were various studies that investigated both the effects of home programme based NDT approaches on functions of the patients with CP [11, 16].

In a study that evaluated the effects of the physiotherapy on 48 subjects with spastic diplegic CP aged 9–12 months, NDT based on the Bobath principle was performed in 24 patients for 6–12 months, whereas the home-based exercise programme was applied in the other group. Although motor development made progress in both groups, statistical significance was seen in favour of NDT based on the Bobath principle [23]

A study with 120 children with CP was performed by Kerem et al. to investigate the effects of the home-based exercise programme on motor developmental levels. However, there was no difference between the motor development of children undergoing the rehabilitation programme based on NDT approaches applied regularly by an experienced physiotherapist 3 days a week. Also, according to the results, home programmes and education of parents can result in success in maintaining the effect of rehabilitation. For this reason, parents’ education in CP rehabilitation is important [16]. Erdoğanoglu and Günel’s study investigated the relationship between motor and functional levels with health-related quality of life in 60 children with cerebral palsy who were in the age range of 5–18

years (mean age of 9.25 ± 3.29 years) and regularly attended a special education centre. In addition, a significant correlation was found between GMFCS and health-related quality of life ($r = -0.337$). Children with cerebral palsy in Group 2 (GMFCS level 4–5) who were examined as more severe cases were affected negatively in terms of health-related quality of life compared to Group 1 (GMFCS 1–3), who were less severe cases. Additionally, it was reported that motor development level and functional status affected the health-related quality of life in children with CP [8]. In a study that evaluated the effects of exercise in children with CP, negative effects on movement pattern, flexibility and spasticity were not found [33]. Studies have shown that aerobic and anaerobic exercise programmes affected aerobic and anaerobic capacity, agility, muscle strength, body mass index, self-perception, gross motor functions, exercise participation level and health-related quality of life [13, 14, 30, 32, 33]. The scheduled and structured exercises for children with cerebral palsy involve repeated movements of skeletal muscles to improve or maintain levels of physical fitness. Many types of exercises including passive stretching, muscle strengthening exercises, static weight-bearing exercises, functional exercises (aerobic and anaerobic capacity and strength training) are performed to improve the motor ability of children with cerebral palsy [11].

To date, there has been limited knowledge about a suitable exercise programme, frequency, intensity, and duration. A strength training programme performed for a minimum of 6 weeks, and three times a week will be effective in improvement of lower extremity muscle performance [30, 32]. Also, an exercise programme for 6 weeks, twice weekly or four times a week might be enough to increase the aerobic capacity of children with CP, and also, a mixed type exercise programme should be performed for 4 or 6 weeks in muscle strength and stride length [33]. Muscle strength and resistance training programmes were used as therapeutic rehabilitation to increase and improve muscle strength and function. Also, the muscle strength training programmes may increase muscle strength and improve motor activity without negative effects in people with CP. 40 children with CP aged between 6.07 years participated in a 6-week, 45 minutes per day, 3 days per week strength training programme. Both the means of hip-knee extensors training weight, and D and E parameters of the GMFM increased [2]. The child with CP is best cared for with an individualized treatment plan. It provides a combination of interventions. Sport serves as an exit point for the expression of emotions such as increasing self-perception of subjects with CP, developing a sense of identity and awareness of disability [10]. It was also emphasized that sport affects well-being positively, and the feeling of being strong. Participation in adapted sports can result in improved health of individuals with disabilities [10, 13].

Muscle contractures lead to a decrease in range of motion and functional movement for children with cerebral palsy. Stretching programmes including passive/active stretching, with prolonged position, play a key role in physical therapy rehabilitation. The stretching exercise will contribute to muscle extensibility, and maintain joint range of motion for functional movement. Children with CP may be encouraged to participate in fun activities to improve levels of physical fitness. For this reason, sports activities such as yoga, tai chi, horseback riding, ballet, and swimming programmes are suitable. This type of functional activities will lead to actively participating in fitness programmes [34]. Adaptive sport positively impacts overall well-being and empowerment. The authors suggest that the act of being physically active leads to feelings of accomplishment and functional efficiency which in turn fosters feelings of empowerment. These feelings of empowerment are often manifested in various constructs associated with psychological well-being such as increased self-efficacy, self-confidence, improved physical self-concept, and self-esteem. Enhanced self-perceptions lead to more stabilized personality traits and mood states which in turn foster a rise in activity level and improved social acceptance [10].

In this study, there were no significant difference in right and left knee flexion, dorsal flexion, hip flexion, abduction, extension, and range of motion in the Experimental and Control group ($p > 0.05$). We think that the range of motion may increase if the exercise period is extended. The underlying mechanism of muscle shortening in CP was reduction of the number of in-series sarcomeres, reduction of in-parallel sarcomeres, and muscle fibre atrophy. The traditional theory that decreased movement causes muscle shortening by reduction of the number of in-series sarcomeres supports classic stretching of the muscles, whereas the explanation of muscle fibre atrophy would indicate the use of muscle strengthening techniques to prevent or reduce contractures [34]. Verschuren et al. stated that functional exercises including aerobic and anaerobic capacity and muscle strength performed 45 minutes twice weekly for 8 months increases lower extremity muscle strength (20% increase), aerobic capacity (38% increase), anaerobic capacity (25%), and agility capacity (15%). Especially, this increase in the parameters causes development in section D of GMFM [32]. In this study, the GMFM score was 72.29 ± 12.87 and 72.46 ± 12.90 before and after the study in EG, respectively. The same values were found to be 72.11 ± 10.91 and 72.17 ± 10.97 before and after the study in CG, respectively. However, there was no significant difference between groups ($P > 0.05$). An improvement was seen in standing parameters.

In a retrospective study performed on 177 patients with CP during five years by Kerem et al., a Bobath NDT home-based exercise programme affected motor development in 103 patients, and ambulation abilities in 91 patients with

CP. Additionally, 32% of spastic, 23% of hypotonic, 14% of dyskinetic, and 10% of athetoid children gained independent ambulation [15].

In another study, a significant difference was found between the GMFCS levels in the first and last controls of the patients who were given a home programme based on NDT. The motor development levels of the patients increased and the disability levels decreased. In addition, when the first and last evaluations were compared, the number of patients who could walk independently was increased and the regular home programme contributed to the child's mobility [19]. In a study, the scores of the GMFM and GMFCS in 586 children with CP aged between 2 and 12 were measured and it was reported that GMFM score played a critical role in determination of GMFCS, and there was a strong relationship between GMFM total score and GMFCS [9]. With the result of this study, we can say that the increase in GMFM will end up with an increase in GMFCS. Due to maintaining continuity of the home-based exercise programme's duration, GMFCS may also be positively affected. Also, the Impact on Family Scale was used to determine the influence of parents on children's disease. The scale covers the financial burden, familial and social impact, personal strain, mastery, and total impact. Both Experimental and Control Groups have close family structure (socio-economical status, mental status, intra-family communication, etc.). However, the mastery parameter was higher in EG than in CG, and a significant difference was found in this parameter between the two groups ($p < 0.05$).

Pain is an important problem for many subjects with cerebral palsy (CP). Pain and injury in early life may cause long-term changes in somatosensory and pain processing. Pain in CP is frequently described as moderate and is located mostly in the abdomen and in the musculoskeletal system. Pain also limits daily activities and satisfaction with life in children and adolescents with CP. Moreover, it has been suggested that pain is one of the most significant factors influencing the quality of life in children with CP [25]. The presence of chronic pain, lasting more than 3 months, was significantly more frequent in subjects with CP (45.31%) than in healthy controls (18.40%). Additionally, children with CP aged 6–10 years suffered especially from pain related to lower limbs (legs, hips, knees, ankles), followed by back pain, head pain, and upper extremity pain (shoulders, arms, elbows, hands) [25]. In a study performed in patients with cerebral palsy aged 3–19 years, it was reported that one-quarter of patients experienced pain (moderate to severe pain) that limited activities and participation, and also negatively affected quality of life. Additionally, the most common cause of pain in children/youth with CP was reported to be the hip subluxation/dislocation, followed by dystonia, musculoskeletal deformity, gastroesophageal reflux, constipation, muscle contractures,

abnormal gait pattern, etc [24]. In a study performed with 2777 children (57% boys; 43% girls), mean age of 7 years, by Alriksson Schmidt and Hagglund, pain was reported as 32.4%, with significantly more girls than boys experiencing pain and significantly more children at GMFCS levels III and V than GMFCS I. Pain frequency increased with age and differences among GMFCS levels were found in the lower extremities and abdomen. Pain in the abdomen and hips was most frequent at GMFCS V, knee pain at level III and foot pain at level I. Additionally, pain was most common in the lower extremities ($n = 624$). Of the 829 who reported pain sites, 325 (36.1%) reported pain in the feet, 193 (21.4%) reported knee pain, 263 (29.2%) reported pain in the hips, 97 (10.8%) had pain in the abdomen, 84 (9.3%) reported back pain, 83 (9.2%) had pain in the head/neck, and 81 (9%) had pain in the arms/hands. Fewer than 15 children reported pain from teeth, pressure, skin wounds or other sites [1]. In this study, 79.54% ($n = 35$) of subjects suffered from lower leg pain (calf muscles), 11.36% ($n = 5$) of participants suffered from foot pain and 9.09% ($n = 4$) of participants suffered from pain of other related regions (i.e. knee, hip, thigh, shoulder, and abdomen, respectively). Our study results showed that the exercise programme used by the Experimental Group (EG) positively affected pain of children with cerebral palsy.

The mean values of the VAS parameter in EG (pre-test, 85.69 ± 17.56 ; and post-test, 88.65 ± 15.07) in CG (pre-test, 84.68 ± 20.94 ; and post-test, 85.29 ± 20.83) showed a significant decrease in pain levels during pre- and post-treatment. The reason for the decrease in pain level may be the effect of the regular multi-model sport activity home exercise programme. Additionally, the decrease in the pain level may also positively affect the quality of life of the subject, and to maintain the rehabilitation programme performed by the family with control of the physiotherapist in the long term was as important as appropriate and early rehabilitation in gain of the ambulation capability, such as standing and walking, of children with CP.

Conclusions and limitations

- If the exercise programme is of interest to the children with CP or they are enthusiastic about, the exercise programme can become a part of the children's life, since the key point of the treatment is a child with CP.
- In addition to the Bobath NDT approach, the multi-model home exercise programme supported with sports activities can be performed by both parents and children with CP easily and willingly.
- Successful results can be obtained by informing the family of children with CP, and explaining about the importance of exercise, and also by regularly doing a home-based exercise programme supported with sport

activities by the families and with active participation of children with cerebral palsy.

- Successful results can be obtained by extending the home exercise programme to 5 days a week and lasting life-long.
- Rehabilitation supported with sport activities, and active participation, and regularly at home, and long duration will provide more successful results to children with CP.

The family trained about the home programme can be effective in the rehabilitation process.

In the light of all this information, we think that the best results from rehabilitation services can only be achieved through a regular and effective home exercise programme prepared for the problems of the patients and can be provided with family education. We can suggest the follow-up studies after 3 or 6 months.

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References

1. Alriksson-Schmidt A., Hägglund G. (2016) Pain in children and adolescents with cerebral palsy: a population-based registry study. *Acta Paediatr.*, 105(6): 665-670.
2. Aye T., Thein S., Hlaing T. (2016) Effects of strength training program on hip extensors and knee extensors strength of lower limb in children with spastic diplegic cerebral palsy. *J. Phys. Ther. Sci.*, 28: 671-676.
3. Beydemir F. (2008) Validity And Reliability of Turkish Version of The Impact on Family Scale: Master Thesis, Denizli: Pamukkale Üniversitesi Sağlık Bilimler Enstitüsü.
4. Budden S. (2005) Cerebral Palsy Etiology and Classification. *Asia Pacific Childhood Disability Update*, 3: 39-44.
5. Carroll K.L., Leiser J., Paisley T.S. (2006) Cerebral palsy: Physical Activity And Sport. *Current Sports Medicine Reports*, 5: 319-322.
6. Dood K.J., Taylor N.F., Graham H.K. (2003) A Randomized Clinical Trial Of Strength Training In Young People With Cerebral Palsy. *Dev. Med. Child Neurol.*, 45: 652-657.
7. Dowling V.M., Barry C. (1990) Cerebral Palsy: Social Class Differences in Prevalence in Relation to Birthweight and Severity of Disability. *J. Epidemiol Community Health*, 44: 191-195.
8. Erdoğanoglu Y., Kerem M. (2007) Investigation of the Relationship between Motor and Functional Levels with Health-Related Quality of Life in Children with Cerebral Palsy. *Toplum Hekimliği Bülteni*, 3(26): 13-18.
9. Erkin G., Aybay C. (2001) Functional Assessment Methods in Pediatric Rehabilitation. *Turk. J. Ph. Med.Rehab.*, 47(2): 16-26.
10. Groof D.G., Lundberg N.R., Zabriskie R.B. (2009) Influence Of Adapted Sport On Quality Of Life: Perceptions Of Athletes With Cerebral Palsy. *Disabil. Rehabil.*, 31(4): 318-326.
11. Günel M.K. (2009) Rehabilitation of children with cerebral palsy from a physiotherapist's perspective. *Acta Orthop. Traumatol. Turc.*, 43(2): 173-180.
12. Hurkmans H.L., Van den Berg-Emons H., Stam H. (2010) Energy Expenditure in Adults With Cerebral Palsy Playing Wii Sports. *Arch. Phys. Med. Rehabil.*, 91(10): 1577-1581.
13. Jan M.M.S. (2006) Cerebral Palsy: Comprehensive Review An Update. *Ann Saudi Med.*, 26(2): 123-132.
14. Kanda T., Yuge M., Yamori Y., Suzuki J., Fukse H. (1984) Early Physiotherapy In The Treatment of Spastik Diplegia. *Dev. Med. Child Neurol.*, 26(4): 438-444.
15. Kerem M., Livanelioglu A., Atas A., Aysun S. (1996) Factors affecting ambulation in children with cerebral palsy and mental motor retardation. A retrospective study. *Turk. Klin. J. Pediatr.*, 5: 147-150.
16. Kerem M., Livanelioglu A., Meriç A., Atas A. (2001) Comparison of The Effects Of Rehabilitation Based on Physiotherapist and Home Exercise Program on Motor Developmental Level in Children with Cerebral Palsy. *Turk. Klin. Physiother. Rehabil.*, 1: 167-172.
17. Klimek L., Bergmann K.C., Biedermann T., Bousquet J., Hellings P., Jung K., Merk H., Olze H., Schlenter W., Stock P., Ring J., Wagenmann M., Wehrmann W., Mösges R., Pfaar O. (2017) Visual analogue scales (VAS): Measuring instruments for the documentation of symptoms and therapy monitoring in cases of allergic rhinitis in everyday health care. *Allergo J. Int.*, 26: 16-24.
18. McDowell B.C., Kerr C., Porkes J., Casgrove A. (2005) Validity Of A Minute Walk Test For Children With Cerebral Palsy. *Dev. Med. Child Neurol.*, 47(11): 744-748.
19. Mutlu A., Tarsuslu T., Kerem M., Livanelioglu A. (2007) The evaluation of home exercise program efficiency in children with cerebral palsy. *Turk. Arch. Ped.*, 42: 112-116.
20. Nolan J., Chalkiadis G.A., Low J., Olesch C.A., Brown T.C.K. (2000) Anaesthesia And Pain Management In Cerebral Palsy. *Anaesthesia*, 55: 32-41.
21. Novak I. (2014) Evidence Based Diagnosis, Health Care, and Rehabilitation for Children With Cerebral Palsy. *J. Child Neurol.*, 29(8): 1141-1156.
22. Palisano R.J., Hanna S.E., Rosenbaum P.L., Russell D.J., Walter S.D., Wood E.P., Raina P.S., Galuppi B.E. (2000) Validation of a Model of Gross Motor Function for Children With Cerebral Palsy. *Phys. Ther.*, 80: 974-985.
23. Palmer F.B., Shapiro B.K., Wachtel R.C., Allen M.C., Hiller J.E., Harryman S.E., Mosher B.S., Meinert C.L., Capute A.J. (1988) The effects of physical therapy on Cerebral Palsy. A controlled trial in infants with spastic diplegia. *N. Engl. J. Med.*, 318(13): 803-808.

24. Penner M., Xie W.Y., Binopal N., Switzer L., Fehlings D. (2013) Characteristics Of Pain In Children and Youth With Cerebral Palsy. *Pediatrics*, 132: e407-e413.
25. Riquelme I., Cifre I., Montoya P. (2011) Age related changes of pain experience in Cerebral Palsy and Healthy Individuals. *Pain Medicine*, 12: 535-545.
26. Shevell M. (2019) Cerebral Palsy To Cerebral Palsy Spectrum Disorder Time For A Name Change? *American Academy of Neurology*, 92(5): 1-3.
27. Te Velde A., Morgan C., Novak I., Tantsis E., Badawi N. (2019) Early Diagnosis and Classification of Cerebral Palsy: An Historical Perspective and Barriers to an Early Diagnosis. *J. Clin. Med*, 8: 1599-1612.
28. Türedi A. (2006) Hemiplejik Serebral Palsili Çocuklarda Protrombotik Gen Mutasyonlarının Sıklığı. Master Thesis, Isparta: Süleyman Demirel Üniversitesi Sağlık Bilimler Enstitüsü.
29. Ustad T., Sorsdahl A.B., Ljunggren A.E. (2009) Effects of Intensive Physiotherapy In Infants Newly Diagnosed With Cerebral Palsy. *Pediatr. Phys. Ther.*, 21: 140-149.
30. Verschuren O., Peterson M.D., Balemans A.C.J., Hurvitz E.A. (2016) Exercise And Physical Activity Recommendations For People with Cerebral Palsy. *Dev. Med. Child Neurol.*, 58: 798-808.
31. Vogtle L.K. (2009) Pain In Adults With Cerebral Palsy: Impact And Solutions. *Dev. Med. Child Neurol.*, 51(4): 113-121.
32. Verschuren O., Ketelaar M., Gorter J.W., Helders P.J.M., Takken T., Viterwaal C.S.P.M. (2007) Exercise Training Program in Children And Adolescents With Cerebral Palsy. *Arch. Pediatr. Adolesc. Med.*, 161(11): 1075-1081.
33. Verschuren O., Ketelaar M., Takken T., Helders P.J.M., Gorter J.W. (2008) Exercise Programs for Children with Cerebral Palsy. *Am. J. Phys. Med. Rehabil.*, 87(5): 404-417.
34. Wiart L., Darrah J., Kembhavi G. (2008) Stretching with Children with Cerebral Palsy: What Do We Know and Where Are We Going? *Pediatr. Phys. Ther.*, 20: 173-178.
35. Yılmaz E. (2005) Serebral Palsi Olgularının Rehabilitasyon Sonuçları. Medical Speciality Thesis, Ministry of Health İstanbul 70. Yıl Fizik Tedavi ve Rehabilitasyon Eğitim ve Araştırma Hastanesi, İstanbul.

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