PHYSICAL REHABILITATION OF CHILDREN WITH CEREBRAL PALSY BY BOBATH-THERAPY METHOD

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ABSTRACT

The article presents the structure and content of a physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center. The objective of the study was to justify theoretically and to develop physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center. Material & methods: theoretical analysis and generalization of special scientific and methodological literature; pedagogical observation, interview, and experiment (ascertaining and formative); motor abilities testing (with the Motor abilities assessment chart by Karel and Berta Bobath); clinical study (neurological examination to determine the severity of motor impairment according to the Gross Motor Function Classification System (GMFCS)); statistical data analysis. Statistical analysis of the motor impairment assessment data after the completion of the physical rehabilitation program revealed an increase in the number of children with GMFCS level I (the mildest form), which was statistically significantly higher ($p < 0.05$) compared to the subjects participated in the standard physical rehabilitation program; the analysis of the relationship between the motor function and the severity of motor impairment in children with cerebral palsy after the completion of the physical rehabilitation program shows the tendency for reduced motor function associated with a low level of motor impairment. The developed physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center was evaluated in the course of the formative experiment. The practical effectiveness of the proposed program was proved by the quantitative changes (at the level of $p < 0.05$) of the studied parameters. The results of the study confirm the effectiveness of the proposed program of physical

rehabilitation focused on the development of motor function and correction of motor impairments.

1.Introduction

The problem of the incidence of infantile cerebral palsy (CP), which is the main cause of childhood disability, remains an urgent issue in pediatric neurology, as the incidence rate does not tend to decrease both worldwide and in Ukraine [1].

In most children with cerebral palsy, organic lesions of the central nervous system cause motor impairments associated with sensory and mental disorders. Furthermore, somatic health, physical development, and regulatory mechanisms of the body are also affected [2].

The issue of physical rehabilitation of children with cerebral palsy is being actively studied by modern scientists all over the world. According to the researchers, physical rehabilitation is the main part of the complex of rehabilitation measures, which is realized through the use of physical culture, which utilizes movements as the main biological function of the body and provides stimulation of growth and development and maintenance of homeostasis (Bobath, 1966). The main task of physical rehabilitation for cerebral palsy in children is to develop motor abilities and motor function through the integrated application of physical rehabilitation methods [3].

2. Literature Review

l of the above and the diversity of the clinical picture of cerebral palsy form the basis for the creation of modern programs combining different methods of physical rehabilitation, the primary means of which is physical exercise, that is confirmed by a large amount of scientific research [4].

It is appropriate to underline that, according to the results of modern scientific researches, application of the Bobath approach in physical rehabilitation of children with cerebral palsy promotes formation of motor skills and free movement in space, both independently and with the additional equipment. Despite the proven positive effects of Bobath therapy techniques (exercise, positional treatment, teaching self-care and child-care skills) on physical rehabilitation of children with cerebral palsy, the issue of their use in many aspects is still unresolved, and there is no differentiation of the means according to the severity of motor impairments [5].

The objective of the study was to justify theoretically and to develop physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation

center [6].

3. Method

3.1. Participants

The ascertaining and formative experiments involved 36 children aged 4 years with spastic diplegia cerebral palsy. The pedagogical experiment application was justified by the process of identifying the benefits of the proposed physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center.

3.2. Materials

Theoretical analysis and generalization of special scientific and methodological literature; pedagogical observation, interview, and experiment (ascertaining and formative); motor abilities testing (with the Motor abilities assessment chart by Karel and Berta Bobath); clinical study (neurological examination to determine the severity of motor impairment according to the Gross Motor Function Classification System (GMFCS)); statistical data analysis [6].

The analysis of special scientific and methodological literature involved modern domestic and foreign scientific literature devoted to the issues of etiology and pathogenesis of cerebral palsy, symptoms, early intervention, features of application and differentiation of physical rehabilitation methods. Particular attention was paid to the study of the benefits of utilizing the approach of Bobath therapy in the physical rehabilitation of children with cerebral palsy [7].

3.3. Procedure

The testing was conducted to assess the children's motor function with the Motor Abilities Assessment Chart by Karel and Berta Bobath. In each of the tests a grading system with values from 0 to 5 were used as follows: 0 – cannot be placed in test posture; 1 – passive movement with the help of physical rehabilitation therapist; 2 – can assume and sustain test posture unaided; 3 – can perform movement unaided, but in abnormal manner; 4 – can perform movement unaided, but imperfect; 5 – can perform normal movement. Using this test, the formation of motor skills was evaluated as follows: rolling to the side and to the prone position, squatting from standing position, etc. [8].

Pedagogical and visual observation with processing and analysis of the data obtained was implemented during each stage of physical rehabilitation. The pedagogical observation consisted of a step-by-step control to evaluate the effectiveness of a 6-month physical rehabilitation course. For this purpose, children were examined at the beginning and at the end of the rehabilitation course, in addition, ongoing assessment was conducted to check the child's response to physical exercise during physical rehabilitation [9].

Visual observation of the impact of physical activity was carried out through direct observing of the child during the class. Discipline, interest in, emotionality, external symptoms of fatigue (sweating, coloring of the skin, coordination of movements, attention, etc.) were separately observed. The interview was used to evaluate the general well-being of the subjects during and after the classes [10].

The ascertaining experiment was used to determine the characteristics of the state of the children who participated in the study and to obtain the baseline data to determine the strategy of implementation of physical rehabilitation program for children with cerebral palsy and to conduct the further formative experiment. The formative experiment was conducted to determine the effectiveness of the proposed physical rehabilitation program incorporating Bobath therapy for preschool 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center [11].

The clinical method included a neurological examination by a neurologist, which determined the severity of motor impairment according to a standardized system for assessing the degree of motor development retardation on the basis of the functional abilities and needs for technical aids and mobility devices of children with cerebral palsy, the Gross Motor Functional Classification System (GMFCS) [12].

For example, GMFCS Level I refers to children, who are able unaided to sit down, to sit on the floor, and to manipulate an object, as well as walks unaided in all settings. Children with Level II GMFCS also are able to sit on the floor unaided, but experience difficulty with balance when manipulating an object, as well as are able to walk only with aids [13].

GMFCS Level III children are able to sit on the floor unaided too, but mostly need the assistance. Children with GMFCS Level III are able to walk a short distance in indoor settings using a hand-held mobility device with supervision or assistance to choose the direction of movement and turns. GMFCS Level IV patients generally require additional devices for sitting or standing and can travel the short distances (within the room) by rolling over, creeping and crawling. GMFCS Level V children are physical disabled and limited in all motor functions. These children are unable to move unaided and are transported in a manual wheelchair in all settings [14].

The analysis and mathematical processing of the data were performed on a personal computer using Biostat, Statistics 6.0, and MS Excel 2013 software packages [14].

4. Results

Assessment of motor function in 4-year-old children with spastic diplegia cerebral palsy using the Motor Abilities Assessment Chart showed that 53.33% of children obtained high scores in test exercises in a prone starting position. Only 36.51% of children were able to make rolling to the side.

Before the study, 22.46% of children were able to assume a test position and held it independently.A small number of children (22.3%) were able to take a kneeling position, to held it, and to crawl freely.

As with the other tests, the proportion of children who were able to freely held the body in a squat sitting position was not significantly different ($p > 0.05$). Only a small number of children (11.27%) had the advanced ability to stand independently.

According to the Gross Motor Function Classification System, only 8.96% of children had GMFCS level I and were able to move freely; 29.85% had GMFCS level II and were able to move using mobility devices; and 61.19% of children had GMFCS level III, were significantly restricted in independent mobility, and could not even use additional equipment.

Comparison of children's parameters of motor function depending on the level of GMFCS showed that the children with GMFCS level I had reduced motor function in all tests before the rehabilitation course. Furthermore, children with GMFCS level III had lower motor abilities than children with GMFCS level II in all test exercises except for those in a supine position.

Table 1. *Analysis of relationship between the motor function and the severity of motor impairment of children before physical rehabilitation course (n = 36)*

Parameter	GMFCS level								
	I, n = 3			II, n = 14			III, n = 19		
	Me	25 %	75 %	Me	25 %	75 %	Me	25 %	75 %
Supine	5.0	5.0	5.0	4.5	4.0	5.0	4.0	4.0	4.0
Prone	5.0	5.0	5.0	4.0	4.0	5.0	4.0	4.0	4.0
Rolling to the side	5.0	4.0	5.0	4.0	4.0	5.0	4.0	3.0	4.0
Rolling to prone position	5.0	4.0	5.0	4.0	4.0	4.0	3.0	3.0	4.0
Sitting	5.0	4.0	5.0	4.0	4.0	4.0	3.0	3.0	4.0
Kneeling	5.0	4.0	5.0	4.0	3.0	5.0	3.0	3.0	3.0
Squatting	5.0	3.0	5.0	4.0	3.0	4.0	3.0	3.0	3.0
Standing	4.0	3.0	5.0	4.0	3.0	4.0	3.0	2.0	3.0

The objective of the developed program was to improve motor function and to correct the symptoms of motor impairments, to implement the prevention of secondary complications, thereby improving the quality of life for ensuring maximum social adaptation of 4-year-old children with spastic diplegia cerebral palsy. The proposed program of physical rehabilitation differed from the standard programs by integrative approach to addressing the problem of physical rehabilitation of children with cerebral palsy through the use of Bobath therapy.

The program of physical rehabilitation in the settings of a specialized rehabilitation center was developed for 4-year-old children with spastic diplegia cerebral palsy, had a total duration of 6 months and included 3 in-patient courses of 10 days duration and two modes of physical activity (normal training and light training). The program was used for physical rehabilitation of 36 children aged 4 years with spastic diplegia cerebral palsy.

In the first course of physical rehabilitation, light training mode of physical activity was used for children with GMFCS levels I, II, and III. In subsequent physical rehabilitation courses normal training mode was used for children with GMFCS levels I and II, whereas light training mode was used for GMFCS level III children.

The objective of the light training mode was to promote gradually increasing overall adaptation of children with cerebral palsy to the environment and regimen of rehabilitation center and to increase the level of physical fitness, familiarity with rehabilitation procedures, preparation for a gradual increase in the number, intensity, and duration of physical rehabilitation procedures, normalization of muscle tone, reduction of pathological reflexes, prevention of further complications, such as contractures and deformities, etc. [14].

Normal training mode was used to reduce pathological reflexes impact on the musculoskeletal system, correction of contractures and deformities, teaching self care skills and skills of caring for a child with special needs, development of motor skills, strengthening the trunk muscles, practicing motor skills, and development of physical skills [14].

The physical rehabilitation program included two components: the basic and the variable ones. In the basic component, the following methods of physical rehabilitation were used: instrumental physiotherapy, sensory integration therapy, and kinesio taping). In the variable component, Bobath techniques were used such as: physical exercise, teaching self-care and child care skills, and positional treatment [18].

Depending on the individual physical abilities of patients, including the GMFCS level, physical exercise sets were designed on the basis of differentiated use of Bobath techniques incorporated in therapeutic gymnastics procedure). In the proposed program of physical rehabilitation, the therapeutic gymnastics procedure included Bobath exercises with gradually increased complexity of the tasks combined with active games and breathing exercises depending on the GMFCS level [15].

The children with GMFCS level III were treated with Bobath exercises, which were grouped into the sets that included breathing exercises and active games depending on functional abilities of the child's musculoskeletal system. Children with GMFCS level II performed more complex Bobath exercises combined with breathing exercises and active games, which were also grouped into sets. The program for GMFCS level I children included the most complex exercises grouped into appropriate sets [15].

A typical design was chosen for Bobath therapy sessions which consisted of introductory, main, and final parts. The introductory part included low-load preventive and general exercises for small and medium muscle groups in a supine initial position, breathing exercises, positional treatment, and active games, as well as was focused on the gradual adaptation of the child to increasing load [15].

The main part combined general and specific exercises. The objectives of the program were achieved through the use of corrective exercises in the following starting positions: prone, lying on the side, sitting, kneeling, and standing; as well as with breathing exercises; teaching self-care skills and caring for a child with special needs; and active games. In the first half of the main part, patients performed physical exercises familiar to them, while the second half included new exercises [15].

In the final part, physical load was decreased due to including breathing exercises and exercises in the sitting and kneeling positions performed at a slow pace and with a small number of repetitions [15].

The results of assessment of children after the course of physical rehabilitation showed that the distribution of children according to the level of motor function development had no statistically significant differences ($p > 0.05$) compared with the baseline data (Table 1). After the course of physical rehabilitation, the differences between the studied parameters were more pronounced and statistically significant ($p < 0.05$).

Indicators of motor function improved by 8.70% in a supine position, by 9.51% in a prone position, by 10.10% in a sitting position, by 12.73% in a kneeling position, by 13.22% in a squatting position, and by 15.95% in a standing position, whereas the abilities to roll to the side improved by 6.38% and to roll to the prone position improved by 7.14%.

***Table 2.*Measures of motor function of children before and after physical rehabilitation course (n = 36)**

Parameter		Average values, points				
		n = 36				
		$\bar{x}$	Me	25 %	75 %	SE
Supine	Before	38.89	55.56	2.78	-	-
	After	75.0*	25.0*	-	-	-
Prone	Before	30.56	61.11	5.56	-	-
	After	72.2*	27.78*	-	-	-
Rolling to the side	Before	30.56	61.11	5.56	-	-
	After	55.56*	38.89	5.56	-	-
Rolling to prone position	Before	16.67	52.78	30.56	-	-
	After	55.56*	38.89*	5.56	-	-
Sitting	Before	13.89	38.89	47.22	-	-
	After	33.33	58.33	8.33*	-	-
Kneeling	Before	19.44	22.22	58.33	-	-
	After	36.11	52.78	11.11	-	-
Squatting	Before	8.33	25.0	58.33	8.33	-
	After	33.33	44.44	22.22	-	-
Standing	Before	5.56	27.78	50.0	13.89	2.78
	After	13.89	50.0	36.11	-	-

Note: * – difference is statistically significant, $p < 0.05$.

After the course of physical rehabilitation, the positive changes were observed in the severity of motor

impairment, as evidenced by an increase of 47.22% in the number of children with GMFCS level I due to a decrease of 38.89% and 8.57% in the number of children with GMFCS level II and III, respectively. Furthermore, 38,89% of GMFCS level III children improved their motor function to the GMFCS level II.

Table 3. *Analysis of relationship between the motor function and the severity of motor impairment in children after the course of physical rehabilitation (n = 36)*

Parameter	GMFCS level								
	I, n = 20			II, n = 14			III, n = 2		
	Me	25 %	75 %	Me	25 %	75 %	Me	25 %	75 %
Supine	5.0	5.0	5.0	5.0	4.0	5.0	4.0	4.0	4.0
Prone	5.0	5.0	5.0	5.0	4.0	5.0	4.0	4.0	4.0
Rolling to the side	5.0	4.0	5.0	4.0	4.0	5.0	3.5	3.0	4.0
Rolling to prone position	5.0	4.5	5.0	4.0	4.0	5.0	3.5	3.0	4.0
Sitting	4.5	4.0	5.0	4.0	4.0	4.0	3.0	3.0	3.0
Kneeling	5.0	4.0	5.0	4.0	4.0	4.0	3.0	3.0	3.0
Squatting	5.0	4.0	5.0	4.0	3.0	4.0	3.0	3.0	3.0
Standing	4.0	4.0	4.5	3.0	3.0	3.0	3.0	3.0	3.0

After the course of physical rehabilitation, the relationship was revealed between the decreased motor function of the children and the severity of motor impairment.

On the basis of the data obtained, we assume the low level of motor function is due to a correspondingly low GMFCS level in 4-year-old children with spastic diplegia cerebral palsy.

5. Discussion and Conclusion

The analysis of the specialized literature has showed that the issue of physical rehabilitation of children with cerebral palsy is still being actively investigated. Experts believe that physical rehabilitation, which is based on the use of physical education approaches, takes a major place in the system of rehabilitation measures [16].

Despite the great interest of scientists and active discussions, the problem of physical rehabilitation of children with cerebral palsy so far is still a relevant field of research [16].

According to modern research, Bobath therapy, which is recognized as an effective approach by scientists around the world, stands out among traditional approaches to physical rehabilitation of children with cerebral palsy. The scientists believe that the Bobath techniques are used in the physical rehabilitation of children with cerebral palsy just due to their influence on the development of motor function at the neurophysiological level [17].

Experimental data have shown that the use of Bobath therapy in physical rehabilitation of children with cerebral palsy promotes development of motor skills and independent mobility. However, despite the positive experience of using Bobath techniques in physical rehabilitation of children with cerebral palsy, the issues of their independent and combined use remain to be addressed.

Therefore, the diversity of the clinical picture of CP and discussions about the effectiveness of the modern approaches to physical rehabilitation for children with CP form the basis for the creation of technologies and programs combining various methods of physical rehabilitation, the leading means of which is physical exercise [18].

The developed physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center was implemented taking into consideration the principles of physical rehabilitation and pedagogics [19].

The involvement of the means of physical rehabilitation and the forms of their use in the developed program was realized taking into account not only the etiopathogenesis of cerebral palsy and the state of the nervous system, but also the results of the assessment of physical development, motor function, and motor disorders that characterize motor development [20; 21].

The results of the scientific study confirmed the effectiveness of the developed physical rehabilitation program incorporating Bobath therapy for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center.

The developed physical rehabilitation program for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center was successfully evaluated in the course of the formative experiment: its effectiveness

was evidenced by statistically significant changes in the studied parameters ($p<0.05$).

After the course of physical rehabilitation, the 4-year-old children with spastic diplegia cerebral palsy had more developed motor functions in all studied starting positions compared to the baseline level.

After the course of physical rehabilitation, the proportion of children with the GMFCS level I (the mildest form) was statistically significantly higher ($p <0.05$) than before the study.

In summary, the study supported the efficiency of implementation and the practical focus of the implemented program, that is evidenced from the positive changes in motor function and outcomes of correction for motor impairment in 4-year-old children with spastic diplegia cerebral palsy.

This study provides grounds to recommend the proposed program of physical rehabilitation for 4-year-old children with spastic diplegia cerebral palsy in a specialized rehabilitation center for use in the rehabilitation centers for disabled children, other relevant rehabilitation centers, and specialized preschool educational institutions.

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