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Method of rehabilitation for children with cerebral palsy using sledge hockey

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ABSTRACT

Purpose of the study: to scientifically substantiate, develop and test the effectiveness of sledge hockey as rehabilitation method for children with cerebral palsy (CP).

Methods: the study involved 12 boys aged 8–14 years with a diagnosis of CP, spastic diplegia, II and III levels of large motor functions development (according to Gross Motor Function Classification System).

The pedagogical experiment was conducted on the basis of the charitable foundation "Eto chudo" in Kirov. Tests to determine the level of physical fitness and the development of fine motor skills were carried out. In addition, a questionnaire among parents, which is aimed at assessing the condition of a child with CP, was conducted.

Results: a comparison of the results of initial and final testing shows that the data is reliable. This indicates that the developed experimental method of rehabilitation of children with CP using sledge hockey is effective. Also, according to the results of the survey of parents, it was concluded that the child's working capacity has increased; the child has become more balanced, and has fewer colds.

Conclusion: when using sledge hockey in the rehabilitation of children with CP, the level of physical fitness and development of fine motor skills increased, as well as the quality of life of children with CP improved.

Keywords: CP, rehabilitation, sledge hockey, physical development, fine motor skills

Conflict of interest: the author declares no conflict of interest.

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Методика реабилитации детей с детским церебральным параличом с использованием средств следж-хоккея

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РЕЗЮМЕ

Цель исследования: научно обосновать, разработать и проверить эффективность методики реабилитации детей с детским церебальным параличом (ДЦП) с помощью средств следж-хоккея.

Материалы и методы: в исследовании приняли участие 12 мальчиков 8–14 лет с диагнозом детский церебральный паралич, спастическая диплегия, II и III уровень развития больших моторных функций (согласно системе классификации больших моторных функций).

Педагогический эксперимент проводился на базе благотворительного фонда «Это чудо» г. Кирова. Были проведены тесты, направленные на определение уровня физической подготовленности и развития мелкой моторики. Кроме того, было проведено анкетирование среди родителей, которое направлено на оценку состояния ребенка с ДЦП.

Результаты: сравнение результатов начального и конечного тестирования показывает, что данные являются достоверными. Это свидетельствует о том, что разработанная экспериментальная методика реабилитации детей с ДЦП с использованием средств следж-хоккея является эффективной. Также по результатам опроса родителей были сделаны выводы, что повысилась работоспособность ребенка, он стал более уравновешенным и меньше болеет простудными заболеваниями.

Заключение: при использовании средств следж-хоккея в реабилитации детей с ДЦП уровень физической подготовленности и развития мелкой моторики увеличился, также улучшилось качество жизни детей с ДЦП.

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Ключевые слова: ДЦП, реабилитация, следж-хоккей, физическое развитие, мелкая моторика

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1. Introduction

At present there is a need to improve the organization of psychological and pedagogical assistance to children with musculoskeletal disorders, since this pathology is extremely common and tends to grow.

Disability due to cerebral palsy (CP) ranks first in the structure of disability in children according to the neurological profile, and its severity is due to motor, mental and language disorders. The main clinical symptom of CP is a impairment of motor function associated with developmental delay and abnormal development of statokinetic reflexes, abnormal tone and paresis. The degree of disability in 20–35 % of patients is so severe that they are unable to self-care, move independently, or engage in learning activities [1].

The problem of CP has been of concern to scientists for a long time. For several years now, children with CP have been under the close attention of special educators. Most children with CP were considered hopeless for treatment and recovery, and therefore few specialized institutions were created for their treatment, and few qualified specialists were trained. Children with CP were sent to social welfare institutions without sufficient treatment [2].

The attitude towards these children has changed over the past 10–15 years after the development of effective treatment methods. Statistics on children with CP show that it is impossible to completely cure the disease. Medicine can only alleviate the patient's condition — minimize pain, gradually build muscle tissue, and prevent the progression of the disease.

According to the federal register of disabled people, the number of disabled children in the Kirov region as of 01.04.2023 is 4883 people, and 49.56 % of them are children at the age of 8–14 [3].

Adaptive sports, including sports for people with intellectual disabilities, provide an opportunity for people with disabilities to assert themselves, increase their activity, self-confidence, improve the quality of life and acquire new social roles, functions, statuses. Game sports that involve collective interaction in the process of training competitive activities (football, hockey, etc.) have a particularly strong impact on the mental aspect of participants, their social characteristics, skills and abilities of social and everyday orientation, which is very important for people with intellectual disabilities.

The impact of sledge hockey on people with disabilities is currently characterized not only by special needs as by increased attention from society to these people. In recent years, the society has started to actively involve people with health problems in social life, but in addition to exclusive training and socialization, these children need rehabilitation of the body.

Sledge hockey is one of the technologies that contribute to improving health. Sledge hockey is a team sport on ice, an analogue of ice hockey for people with disabilities.

The use of various means of physical rehabilitation plays crucial role in the process of restoring the impaired functions of patients with CP, taking into account the individual characteristics of each patient [4–8].

Physical rehabilitation of disabled children with musculoskeletal disorders based on the selection of effective means of health and correctional orientation in physical education classes contributes to the targeted correction and formation of motor skills of disabled children [9, 5, 10–12].

Since adaptive physical education (APE) is a broad area of activities aimed at strengthening health, active comprehensive and harmonious development of personality, improvement of natural inclinations and abilities genetically embedded in each person, it allows to effectively solve the problem of integrating people with disabilities into society.

In the field of development of youth sledge hockey and the prospects for the rehabilitation of adolescents using this adaptive sport, the studies of D.A. Astakhov (2021), K.A. Badrak (2015), A.A. Gaiduk (2020, 2022) [13–16] were studied.

At the same time, the relevance of the problem is determined by the insufficient study of the rehabilitation effect when using means, methods, and methodological techniques of sledge hockey at the initial stage of sports training of children diagnosed with CP, taking into account their psychophysical and psychomotor characteristics.

After analyzing scientific and methodological literature, it was possible to identify a contradiction between the need for rehabilitation of children with CP and insufficient study of the rehabilitation effect of sledge hockey. There are many methods of rehabilitation for children with this condition, but they are not always able to motivate such children to exercise; sledge hockey has a competitive element, so, there is an interest of children in the best result of a team.

The revealed contradiction served to formulate the scientific problem of the research: if sledge hockey classes can improve the level of physical fitness, development of fine motor skills and, in general, the quality of life of children with CP.

The purpose of the research is to scientifically substantiate, develop and test the effectiveness of sledge hockey as rehabilitation method for children with CP.

2. Methods

The study involved 12 boys aged 8–14 years with a diagnosis of CP, spastic diplegia, II and III levels of large motor functions development (according to Gross Motor Function Classification System).

The pedagogical experiment was conducted on the basis of the charitable foundation "Eto chudo" in Kirov. The study involved 12 children who study at this school. The study was conducted in three stages.

Disorders of the musculoskeletal system in the form of scoliosis, contractures in the joints, and chronic diseases of the respiratory system were distinguished from concomitant diseases.

The selection of children was carried out on the basis of medical reports and with the written consent of the parents. The previous experience of physical activity in all children included mainly massage and therapeutic gymnastics.

To achieve this goal, the following tasks were solved:

1. To conduct a theoretical analysis of the means, forms and methods of adaptive physical education, identify the possibility of their use in sledge hockey for children with CP.

2. To study features of physical development and physical fitness of children diagnosed with CP.

3. To develop methods for the rehabilitation of children with CP using sledge hockey.

4. To substantiate the effectiveness of the rehabilitation method for children with CP using sledge hockey in the course of the pedagogical experiment.

To study the possibility of correcting motor disorders in children with CP in accordance with the set tasks, both theoretical and empirical research methods were used: analysis and generalization of scientific and methodological literature, observation, questionnaire, testing, experiment, and the method of mathematical statistics.

To assess the motor capabilities of children with CP, tests that are described in the physical training standards, taking into account the age of children undergoing sports training in sledge hockey, were used.

The standards of sports training and their correlation at the stages of sports training in groups involved in this sport are given in Table 1.

To determine the level of development of fine motor skills in children with CP, the following tests were used:

1) Test to identify the switch ability of finger movements [17].

Consists of two tests: "Fist — edge — palm", "Playing the piano".

2) Test to determine the full range of finger movements [18].

3) Test to determine the level of development of the ability to maintain a given position of the fingers of the hand [18].

4) Test to determine the level of accuracy of movement of the fingers of the dominant hand [18].

5) "Lowering the stick — reaction" [19].

6) To assess the degree of development of skeletal muscles, wrist dynamometry (maximum wrist strength) of the right and left hands was assessed using child's hand dynamometer.

In the end of the experiment, the survey of parents on improving the condition of children involved in sledge hockey according to the developed methodology was conducted. The questionnaire includes 9 questions-statements and 5 answer options:

1) Has the child become less likely to get colds after he/she started playing sledge hockey?

2) Has the child's coordination improved?

3) Has the child's ability to work improved?

4) Has the child become more sociable and goal-oriented?

5) Has the child become more self-confident?

6) Has his/her academic performance at school improved?

7) Has the child become more balanced?

8) Has the family microclimate improved?

Table 1

Standards of general physical and special physical fitness for enrollment in groups at the initial training stage

Таблица 1

Нормативы общей физической и специальной физической подготовки для зачисления в группы на этапе начальной подготовки

Physical quality to be developed	Control exercises (tests)*
Speed	Running on special sleds on ice for 10 m (without taking into account the time)
Coordination	"Snake" on special sleds around 5 poles (without taking into account the time)
Endurance	Running on special sleds around the perimeter of the court (without taking into account the time)
Strength	Lifting a medicine ball (1 kg), lying on a bench up with straight arms from the chest (at least 5 times)
Strength endurance	Lifting the body from a lying position on a bench to a sitting position (at least 3 times)
Speed-strength abilities	Throwing a medicine ball (1 kg) with hands from behind the head forward while sitting on a bench (without taking into account the result)

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The study weas conducted with the approval of the physician and under the supervision of the exercise therapy instructor. The parents also monitored the course of the study. The pedagogical experiment was conducted with their written consent.

This study was approved by the Ethics Committee of Vyatka State University (Protocol No 5 from 11.01 2024).

The mathematical statistics method was used to process the results using a computer. Statistical processing of the research results was carried out using methods of variation statistics. The following statistical indicators were determined: the arithmetic mean of the variation series (M), the mean square (standard) deviation (σ), the average error of the arithmetic mean (m) and the parametric t–Student criterion (t).

3. Results

After carrying out control measurements in the beginning of the experiment, the physical fitness data of children with CP between 8-14 years of age participating in the experiment was obtained. Table 2 presents the average group indicators of the level of physical fitness of children aged 8-14 with CP in the experimental group in the beginning of the pedagogical experiment.

To assess the level of fine motor skills development in children with CP, the control tests described above were used. The results are presented in Table 3.

Based on the analyzed scientific and methodological literature, the conducted ascertaining experiment, the experimental methodology was developed aimed at developing the physical fitness of children with CP between 8–14 years of age by means of sledge hockey.

The methodological and theoretical basis of the experimental methodology for developing physical fitness and fine motor skills of children with CP between 8–14 years of age was the works of domestic and foreign authors:

The experimental methodology was based on general methodological principles and principles of sports training.

The goal of the developed methodology: to increase the level of physical fitness, fine motor skills using specially developed sets of exercises at the initial stage of training young sledge hockey players and, as a result, to improve the quality of life.

The structural model of sports training for sledge hockey players between 8–14 years of age is shown in Figure 1.

Nine months after the start of classes, the final stage of the study was conducted to assess the effectiveness of using the

Table 2

Average group indicators of the level of physical fitness of children at the age of 8–14 with CP in the experimental group in the beginning of the pedagogical experiment (n = 12)

Таблица 2

Среднегрупповые показатели уровня физической подготовленности учащихся 8–14 лет с детским церебральным параличом в экспериментальной группе на начало педагогического эксперимента (n = 12)

№	Test	Experimental group $M_{exp} \pm m$
1	Running on special sleds on ice for 10 m, seconds	6.15 ± 0.29
2	"Snake" on special sleds around 5 poles, seconds	11.9 ± 0.56
3	Running on special sleds around the perimeter of the court (endurance), seconds	93.6 ± 7.1
4	Lifting a medicine ball (1 kg), points	2.83 ± 0.4
5	Lifting the body from a lying position on a bench to a sitting position, points	2.42 ± 0.32
6	Throwing a medicine ball (1 kg) with hands from behind the head forward while sitting on a bench, points	2.52 ± 0.13

Table 3

Results of the ascertaining pedagogical experiment to assess the level of fine motor skills development in children CP between 8–14 years of age, who play sledge hockey, in the beginning of the pedagogical experiment

Таблица 3

Результаты констатирующего педагогического эксперимента по оценке уровня развития мелкой моторики у детей с ДЦП 8–14 лет, занимающихся следж-хоккеем, в начале педагогического эксперимента

№	Test	Experimental group $M_{exp} \pm m$
1	Test to identify the switch ability of finger movements, points	2.56 ± 0.16
2	Test to determe the full range of motion of the fingers, points	2.89 ± 0.21
3	Test to determine the level of development of the ability to maintain a given position of the fingers of the hand, points	3.14 ± 0.17
4	"Lowering the stick — reaction", points	3.25 ± 0.17

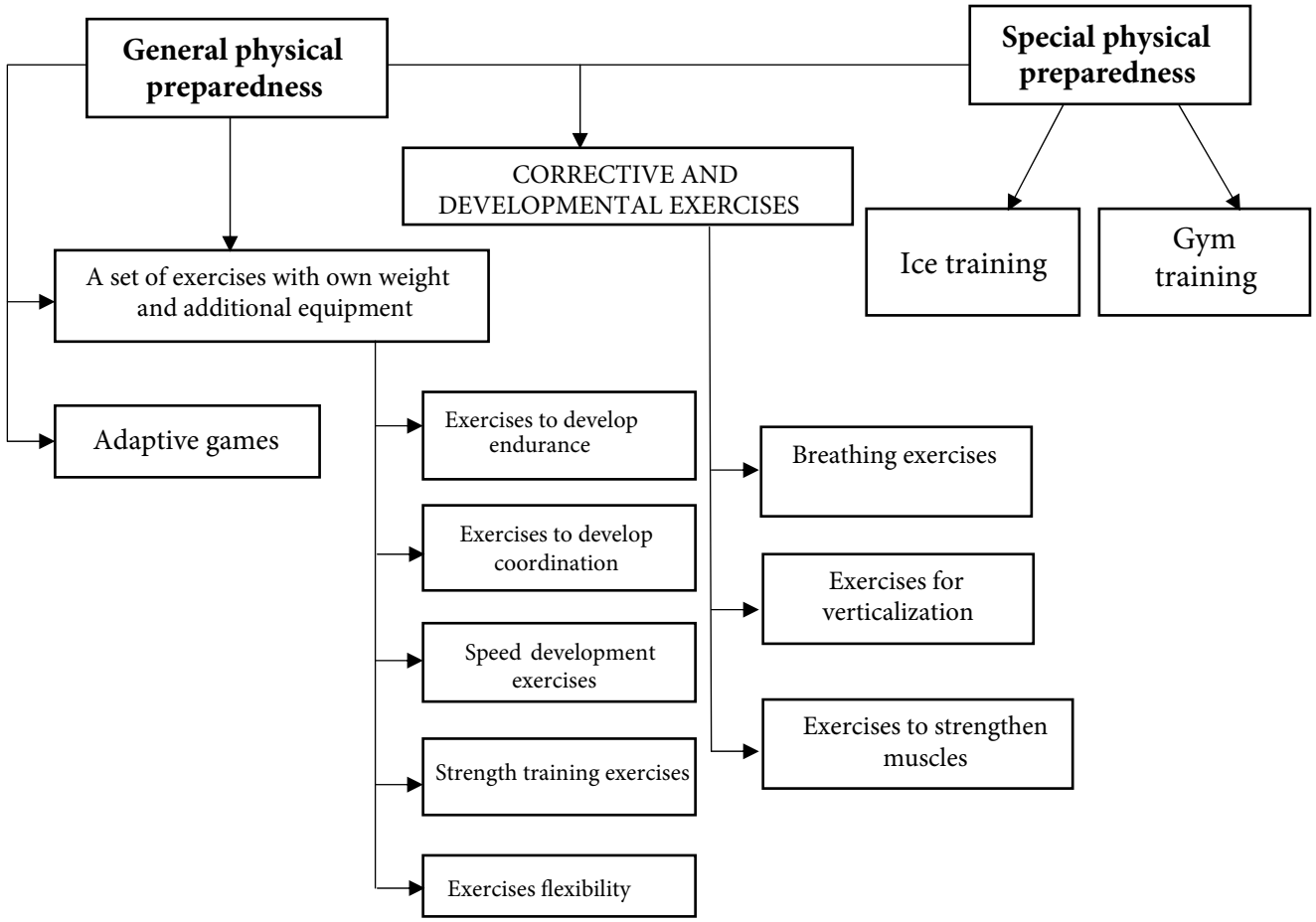

Fig. 1. The structural model of sports training for sledge hockey players between 8–14 years of age
Рис. 1. Структурная модель спортивной подготовки следж-хоккеистов 8–14 лет с диагнозом детский церебральный паралич

experimental methodology of classes to develop coordination skills in children with CP between 8–14 years of age by means of playing sledge hockey. For this purpose, repeated testing was conducted.

The comparative results of physical fitness testing at the initial and final stages of the experiment are presented in Table 4.

The comparative results of testing the level of physical fitness of children with CP between 8–14 years of age in the beginning and end of the pedagogical experiment show that there was a reliable increase in the level of development of speed, coordination, endurance, and strength.

The comparative results of testing the level of development of fine motor skills of children with CP between 8–14 years of age in the beginning and end of the pedagogical experiment show that there was a significant increase in the results.

Based on the obtained results, it can be judged that adaptive physical education classes according to the developed methodology had a positive effect on the test results. Assessing the obtained data on the level of physical fitness of 8–14 years old with CP in the end of the experiment, an improvement in the results was observed for all indicators.

Figure 6 graphically presents the results of the survey after the pedagogical experiment (n = 12).

According to the figure, it is evident that the experimental method of sports training of sledge hockey players using corrective and developmental exercises had a positive effect on the condition of children with CP. The parents noted that the quality of life of their children with developmental disabilities improved after the classes. It was emphasized that the child's academic performance improved, he became calmer and was less likely to suffer from colds.

A positive increase in communication skills and determination of children was noted; children started to feel more self-confident. Many parents noted an improvement in the microclimate in the family due to the fact that children were engaged in adaptive sports training.

Thus, as a result of the formative pedagogical experiment, it was revealed that the level of indicators increased, which proves the effectiveness of the developed methodology. Consequently, the methodology can be recommended for using when developing coordination, speed, strength abilities in children with CP 8–14 years of age by means of sledge hockey, as an additional means of developing physical qualities in the implementation of a complex of adaptive physical education.

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Table 4

Comparative results of physical fitness testing of children with CP between 8–14 years of age at the initial and final stages of the pedagogical experiment (*n* = 12)

Таблица 4

Сравнительные результаты тестирования уровня физической подготовленности учащихся 8–14 лет с детским церебральным параличом на начало и конец педагогического эксперимента (*n* = 12)

Test	Results of the experimental group tests		*t* (2.07)	*p* (0.05)
	in the beginning	in the end		
	$M_{эксп} \pm m$	$Mк \pm m$		
Running on special sleds on ice for 10 m, seconds	6.15 ± 0.29	4.24 ± 0.26	4.90	$p \le 0.05$
"Snake" on special sleds around 5 poles, seconds	11.9 ± 0.56	9.87 ± 0.45	2.83	$p \le 0.05$
Running on special sleds around the perimeter of the court (endurance), seconds	93.6 ± 7.1	73.2 ± 6.10	2.18	$p \le 0.05$
Lifting a medicine ball (1 kg), points	2.83 ± 0.40	4.17 ± 0.39	2.40	$p \le 0.05$
Lifting the body from a lying position on a bench to a sitting position, points	2.42 ± 0.32	3.67 ± 0.38	2.42	$p \le 0.05$
Throwing a medicine ball (1 kg) with hands from behind the head forward while sitting on a bench, points	2.52 ± 0.13	2.91 ± 0.12	2.20	$p \le 0.05$

Table 5

Comparative results of testing the level of development of fine motor skills of children a with CP between 8–14 years of age in the beginning and end of the pedagogical experiment (*n* = 12)

Таблица 5

Сравнительные результаты тестирования уровня развития мелкой моторики учащихся 8–14 лет с детским церебральным параличом на начало и конец педагогического эксперимента (*n* = 12)

Test	Results of the experimental group tests		*t* (2.07)	*p* (0.05)
	in the beginning	in the end		
	$Mэ \pm m$	$Mк \pm m$		
Test to identify the switch ability of finger movements, points	2.56 ± 0.16	3.11 ± 0.18	2.28	$p \le 0.05$
Test to determine the full range of motion of the fingers, points	2.89 ± 0.21	3.58 ± 0.23	2.22	$p \le 0.05$
Test to determine the level of development of the ability to maintain a given position of the fingers of the hand, points	3.14 ± 0.17	3.68 ± 0.19	2.12	$p \le 0.05$
"Lowering the stick — reaction", points	3.25 ± 0.17	3.83 ± 0.21	2.15	$p \le 0.05$

4. Discussion

As a result of the analysis of scientific and methodological literature, it was revealed that many authors dealt with the problem of physical rehabilitation of children with disabilities in general. Physical rehabilitation of disabled children with musculoskeletal disorders based on the selection of effective means in physical education classes contributes to the targeted correction and formation of motor skills of disabled children, which is confirmed in research [5, 4, 9, 10].

In the process of reviewing literary sources, almost no use of Paralympic sports for the purpose of physical rehabilitation of disabled children was found. Nowadays, there are a huge number of different sports and only 22 of them are adapted for people with disabilities.

According to the scientific and methodological literature, the authors did not identify specific results of rehabilitation of children with CP using sports games. The exception was the article by V.O. Osipov and A.S. Chubukov, related to the use of only badminton elements. The authors have developed a comprehensive program of extracurricular badminton classes to correct motor disorders of high school students with the consequences of CP in the late residual stage with the I level of development of large motor functions (independent walking without restrictions) [8]. However, we have not identified studies of children with CP with II and III levels of large motor functions development in team sports, such as sledge hockey.

In addition, our attention should be paid to a study related to the effectiveness of the technology of medical rehabilitation of Paralympians involved in playing sports, in particular wheelchair basketball [20]. The authors proved that active-passive electrical stimulation and active mechanotherapy in

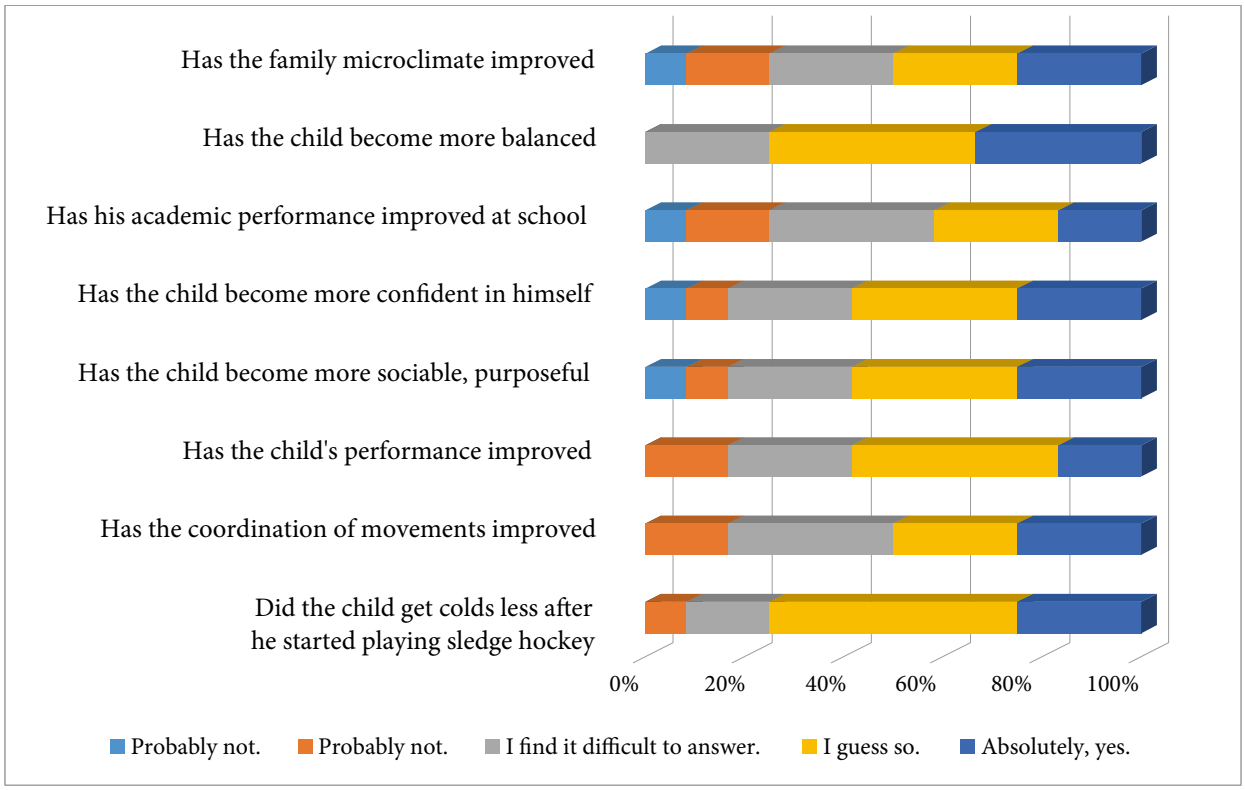

Fig. 2. Results of the survey after the pedagogical experiment
Рис. 2. Показатели анкетного опроса после проведения педагогического эксперимента

Paralympians with traumatic spinal cord disease at the lumbar level of injury can significantly increase the indicators of free movement, respectively, the effectiveness of rehabilitation and quality of life of patients.

Thus, when studying the scientific literature, the relevance of the problem was revealed. It is determined by the insufficient study of the rehabilitation effect of the use of means, methods, and methodological techniques of sledge hockey at the initial stage of sports training of children diagnosed with CP, taking into account their psychophysical and psychomotor characteristics.

The presented data of the ascertaining experiment in the beginning of using the method indicate a low level of physical development and physical fitness of children diagnosed with CP, which were improved during the course of the study.

Based on the results of the ascertaining experiment and the identified characteristics of children with disabilities, the experimental methodology for the sports training of sledge hockey players was developed and a set of corrective and developmental exercises was introduced to improve the muscles using own weight and specialized modern equipment (expanders, medicine balls, sliders, fitness rubber), as well as with the addition of a final exercises set aimed at stretching and relaxing muscles, breathing exercises, exercises for verticalization and strengthening the muscles to increase vitality. These sets of exercises contribute to the active development of postural muscles, correction of ataxia and improvement of proprioception.

The main differences between the experimental method of physical rehabilitation of children with CP and the currently existing methods of rehabilitation of such patients with this disease is the combination of innovative methods of sports rehabilitation using sledge hockey tools and sets of corrective and developmental exercises, which will allow maximum involvement of children of this category in training and competitive activities.

The effectiveness of the developed methodology was tested during the pedagogical experiment and confirmed by the following results:

– in the test “Running on special sleds on ice for 10 m” the results improved by 68.9 %;

– in the test “Snake” on special sleds around 5 poles” the results improved by 82.9 %

– in the test “Running on special sleds around the perimeter of the court” the result increased by 78.2 %

– in the test “Lifting a medicine ball (1 kg)”, the results improved by 47.3 %;

– in the test “Lifting the body from a lying position on a bench to a sitting position” the results improved by 51.6 %;

– in the test “Throwing a medicine ball (1 kg) with hands from behind the head forward while sitting on a bench” the results improved by 15.5 %.

These data indicate a positive impact of exercises according to the developed method in the training process of children between 8–14 years of age diagnosed with CP.

Consequently, the used method can be recommended for a wide use in work on the development of coordination, speed, strength abilities, fine motor skills and, as a result, in general, improving the quality of life of children with CP between 8–14 years of age by means of playing sledge hockey.

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Limitations. The small sample size of the subjects is explained by the specifics of sledge hockey training sessions under the guidance of one coach. Possible bias in the selection of participants in the experiment is excluded, since almost all children who received medical admission and parental consent participated in it. The limitations in the duration of the study (9 months) are explained by the seasonality and structure of the training process in sledge hockey.

5. Conclusions

Thus, as a result of the formative pedagogical experiment, it was revealed that the level of indicators has increased, which indicates the effectiveness of the methodology developed by authors. Therefore, the sledge hockey can be recommended for wide application in the development of coordination, speed, and strength abilities in children aged 8-14 years with CP as an additional means of developing physical qualities in the implementation of an adaptive physical culture complex.

Author contribution:

Alexander G. Kapustin — conceptualization and design of research, data collection, analysis and interpretation, preparation of the article and its review from the point of view of significant intellectual content.

Вклад автора:

Капустин Александр Григорьевич — концептуализация и дизайн исследования, сбор данных, их анализ и интерпретация, подготовка статьи и ее рецензия с точки зрения значимого интеллектуального содержания.

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