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Efficiency of the pedagogical model of teaching the basic competitive swimming strokes to children with cerebral palsy
Eficiencia del modelo pedagógico de enseñanza de los estilos básicos de natación competitiva a niños con parálisis cerebral

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Abstract: Objective: According to many outstanding scholars, sport is essential for social adaptation and integration of people with disabilities. Therefore, it is important to research innovative models for teaching competitive swimming strokes to children with cerebral palsy. The objective of the study is to design the pedagogical model of teaching the basic competitive swimming strokes to children with cerebral palsy and to evaluate its effectiveness for mastering the front crawl swimming stroke. Material and methods: A selective research methodology was used. It involved direct data collection thanks to the survey of the participants. The results showed that the level of mastering the swimming stroke used by children who applied this designed model was objectively higher in comparison with the same indicators of training related to the traditional method. Conclusions: Drawing on the assessment of swimming stroke efficiency, we believe that the proposed pedagogical model of teaching the basic competitive swimming strokes to children with cerebral palsy is effective.
Key words: Cerebral palsy, Pedagogical model, Swimming stroke, Front and Back crawl stroke.

Resumen: Objetivo: Según muchos estudiosos destacados, el deporte es fundamental para la adaptación social y la integración de las personas con discapacidad. Por lo tanto, es importante investigar modelos innovadores para enseñar brazadas de natación competitiva a niños con parálisis cerebral. El objetivo del estudio es diseñar el modelo pedagógico de enseñanza de los estilos básicos de natación competitiva a niños con parálisis cerebral y evaluar su efectividad para dominar el estilo de natación estilo crol. Material y métodos: Se utilizó una metodología de investigación selectiva. Implicó la recopilación directa de datos gracias a la encuesta a los participantes. Los resultados mostraron que el nivel de dominio de la brazada de natación utilizado por los niños que aplicaron este modelo diseñado fue objetivamente mayor en comparación con los mismos indicadores de entrenamiento relacionados con el método tradicional. Conclusiones: Basándonos en la evaluación de la eficiencia de la brazada de natación, creemos que el modelo pedagógico propuesto de enseñar las brazadas básicas de natación competitiva a niños con parálisis cerebral es eficaz.
Palabras clave: parálisis cerebral, modelo pedagógico, brazada de natación, brazada de crol de frente y espalda.

Introduction

Swimming is a sport with traditional popularity around the world among all segments of the population, including people with disabilities (spinal cord injuries, limb amputations, polio, cerebral palsy). In recent years there has been a tendency to increase competition in sports for the disabled, especially in the types included in the program of the Paralympic Games such types include swimming (Bullough, Davies & Barrett, 2015; Benèuriková & Matúš, 2017; Gorshova et al., 2017; Sánchez-Lastra et al., 2019; Mandzák, Mandzáková & Pavlíková, 2020). This requires improving the efficiency of the training process not only at the stage of achieving and maintaining higher performance, but also at the initial stage (at the stage of learning swimming strokes).

The training of swimmers with disabilities has its own specificity due to their physical and psychological characteristics. Researches reveal different aspects of this problem. However, only a few scientists in their studies disclose the peculiarities of studying the competitive swimming strokes for such a special group of people (Zugno, Martínez, Lara & Sanz-Arribas, 2016; Papadimitriou, Loupos, Tsalis & Manou, 2017; Gorla et al., 2018; Sánchez-Lastra et al., 2019; Moura et al., 2020). Some researchers have been devoted to the problems of training children with the consequences of cerebral palsy (Moretto, Pelayo, Chollet & Robin, 1996; Prins & Murata, 2008; Gorter & Currie, 2011; Priego Quesada,

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Lucas-Cuevas, Llana-Belloch & Perez-Soriano, 2014; Murvanidze, 2017; Varfolomeeva, Podolyaka, Panova, & Dobryakova, 2017; Henríquez et al., 2020). The analysis of scientific researches has shown that the overwhelming majority of them have been devoted to the pedagogical approach to teach the swimming strokes, but they do not include the use of modern information technologies, such as teaching applications and platforms, as well as smart watches (Skaliy, 2002; Ichikawa, Ohgi, Miyaji & Nomura, 2003; Kashuba, Yukhno & Khmelnytskaia, 2013; Jensen, Prade & Eskofier, 2013; Melnyk, 2017). So, there is a need to adopt a specific pedagogical approach for teaching people with disabilities, in particular those who have suffered from the consequences of cerebral palsy. There is a contradiction between the rapid development of innovative technologies in all sectors of public life and their inadequate use in the training process of swimmers with cerebral palsy (Görner, Kruèanica, & Sawicki, 2020). This proves the urgency of designing a special set of approaches for teaching competitive swimming strokes while teaching the sportsmen with cerebral palsy, which will allow to master the strokes choosing an approximate complex of exercises that takes into account the peculiarities of motor disturbance in accordance with the form of cerebral palsy in comparison with traditional existing methods (Moretto, Pelayo, Chollet & Robin, 1996).

Thus, the objective of the study is to design a pedagogical model of teaching basic competitive swimming strokes to children with cerebral palsy and to evaluate its efficiency for mastering the front crawl swimming strokes.

Material & methods

A selective research methodology was used. It involved direct data collection thanks to the survey of the participants.

Participants

The sample was made up of 15 highly qualified Ukrainian swimming coaches aged between 38 to 67 with minimum work experience of 13 years from seven different Ukrainian regions. There were twelve men and three women. Among participants there were 29 boys aged 8-10 years old diagnosed with cerebral palsy (functional class S7-S8 by WPS classification): 12 boys with spastic diplegia and 17 boys with hemiparetic form of cerebral palsy.

Procedure

The participats were randomly divided into two groups: an intervention group included 14 boys, in which 6 boys were with spastic diplegia and 8 boys were with hemiparetic form; a control group consisted of 15 boys, which included 6 boys with spastic diplegia and 9 boys with hemiparetic form of cerebral palsy. A written assent was obtained from the children. Moreover, a written consent was obtained from the parents prior to data collection.

The pedagogical model of teaching the basic competitive swimming strokes to children with cerebral palsy as a part of a pedagogical proposal has been developed on the basis of Sumy State University where the pedagogical experiment was conducted.

The sequence of the realization of the pedagogical model designed by the authors consists of the following stages:

1. Enlisting and forming the groups of children with cerebral palsy.
2. Familiarity with the contingent of groups and the peculiarities of their motor disturbance, that is, an analysis of their medical cards, an interview with their parents, doctors, etc.
3. Planning the training process.
4. Selection of the forms, means and methods of teaching swimming individually for each child, taking into account the forms of cerebral palsy, the existing motor disturbance, in accordance with each training session, the stage of training motor activity, abilities, the technical element of training and all features of initial training using the web-based information system «SwimCP».
5. Conducting lessons on swimming safety.
6. Organization and conducting training sessions.
7. Control methods of the level of mastering the stroke of competitive swimming of children with cerebral palsy.

The pedagogical experiment involved two homogenous groups of the boys with cerebral palsy (intervention and control groups). Structuring of groups was carried out on the basis of age, a WPS classification level, a form of cerebral palsy and possession of the swimming stroke of the studied cohort. The intervention group learned to swim on the basis of the designed model of teaching basic competitive swimming strokes and the control group – by using traditional common methods. The intervention was applied by the authors of the article – V. Bosko and O. Tomenko with the collaboration of Sumy Regional Center for Physical

Culture and Sports for the Disabled «Invasport» swimming coaches. Swimming sessions were held for seven months three times a week for an hour and a half each in a 25-meter swimming pool. Recommended water temperature was 27-29 degrees. Sumy Regional Athletic Board approved the protocols used in this study.

Methods

An expert assessment of the swimming stroke was carried out live using a structured interview according to the following criterion: the position of the swimmer's body (points), the movement of legs (points), the movement of hands (points) and the coordination of movements (points), which are the main indicators of effective swimming stroke (Bosko, 2016). The observers assessed each criterion separately for children with spastic diplegia and hemiparetic form of cerebral palsy in a differentiated way. The experiment took part live. The assessment was conducted by the authors at the end of the pedagogical intervention. As a result, each child received the corresponding points. The assessment was conducted by 6 skilled observers between 50 to 67 years (the representatives from the swimming coaches group from Sumy region). They formed a focus group who analyzed the proposed pedagogical model. They had a sufficient experience of training the athletes with the consequences of cerebral palsy and expressed their desire to participate in the survey. The observers' reports were checked and transferred into a differentiated-general grade, that is, after determining the effectiveness of the swimming stroke, the overall grade was summed up and calculated.

It should be noted that at the beginning of the experiment forming there was no statistically significant difference between the control and the intervention groups ($p > 0.05$) in terms of their physical capacities in general.

Data analysis

The processing of numerical data was carried out using statistic methods. The means and standard deviations were calculated for the intervention and control groups. The U-Mann-Whitney criterion for independent groups was used to assess the significance of the differences between the groups. The statistical reliability of the coefficient of concordance was estimated using Pearson's criterion $\div^2$. SPSS Statistics 28 was used to analyze the data. For all tests an alpha level of statistical significance was set at $p<0.05$.

To determine the statistical criterion for the reliability of the differences between the data of the control and intervention groups.

Results

As the results of the research, we have designed a pedagogical model of teaching the basic competitive swimming strokes to children with cerebral palsy which should be used at the initial stage of training. This model allows a coach to organize the process of initial teaching of such children based on the consideration of motor disturbance of children with spastic diplegia and hemiparetic form of cerebral palsy. The proposed model takes into account the specifics of the assimilation of motor actions in the aquatic environment; assumes the use of kinematic characteristics of skilled swimmers with cerebral palsy as a reference point for swimming strokes, which should be approached; involves the use of the latest information learning tools; it based on an individual approach to teaching swimming.

The content of teaching swimming stroke in accordance with the pedagogical model contains nine stages depending on the forms of cerebral palsy (Table 1).

Table 1
The content of teaching swimming technique in accordance with the pedagogical model depending on the forms of cerebral palsy

Forms of cerebral palsy	
Hemipartic form	Spastic diplegia
1 Technique of maintaining a streamlined position of the body in water	1 Technique of maintaining a streamlined position of the body in water
2 Breathing technique	2 Breathing technique
3 Technique of foot movements	3 Technique of foot movements
4 Technique of foot movements and breathing	4 Technique of foot movements and breathing
5 Technique of hand movements	5 The technique of foot movements or the correct position of the legs in a streamlined position
6 Technique of hand movements and breathing	6 The technique of foot movements or the correct position of the legs in a streamlined position and breathing
7 Technique of movements of legs and arms holding the breath	7 The technique of foot movements or the correct position of the legs in a streamlined position and technique of movements of arms holding the breath
8 Technique of movements of legs and arms with breathing	8 Technique of foot movements or position of legs in a streamlined position and technique of movements of hands with breathing
9 Swimming technique in full coordination	9 Swimming technique in full coordination

Teaching the front and back crawl stroke was carried out by using a parallel-sequential method with separate elements. The duration of the training stage depends on the mastery of swimming movements. The instruction of each task included the following:

- acquaintance with the movement in general;
- demonstration of the element of swimming stroke by a coach with a brief analysis of the stroke of movement;
- methodical instructions with statement of motor tasks and possible mistakes;
- practical implementation: a) on board the

swimming pool; b) in water (with support, on the spot; with support, in motion; without support, in motion).

In order to verify the effectiveness of the model, the survey has been carried out to identify the observers' opinion about the level of mastering the front crawl swimming stroke by children with cerebral palsy.

The difference in points on body position when swimming front crawl, received by children with the consequences of cerebral palsy of the control and intervention groups, is 14 %. On the movements of legs the children of the control group received 12 % lower points than the children of the intervention group. On the movements of hands the difference is 5 %. The coordination of movements of the children from control group was estimated at 8 % less than that of the intervention group. The children of the control group during front crawl swimming received the highest score for the movements of hands, and the lowest – for the coordination of movements. These figures are 3.8±0.2 and 3.5±0.3 respectively. The children of the intervention group received the highest points during front crawl swimming for the body position, and the lowest ones – for the coordination of movements. These figures are 4.2±0,5 and 3.8±0.3 respectively (Table 2).

Table 2
Comparison of the level of swimming technique mastering on swimmers with consequences of cerebral palsy at the end of the experiment

Criteria	[1]CG (n=15)	[2]IG (n=14)	Reliability of differences	Significance level
	mean ±[3]SD	mean ±[3]SD	([4]U)	(?)
Body position	3.6±0.5	4.2±0.5	48	< 0.05
Movements of legs	3.6±0.4	4.1±0.5	54	< 0.05
Movements of hands	3.8±0.2	4.0±0.2	51	< 0.05
Coordination of movements	3.5±0.3	3.8±0.3	58	< 0.05
General grade of technique	3.7±0.2	4.0±0.3	32	< 0.05

Note: [1]CG – control group; [2]IG – intervention group, [3]SD – standard deviation, [4]U – Mann–Whitney U-test

Thus, it has been shown that the level of mastering the swimming strokes by children whose training was grounded on the designed model is objectively higher on the average 8 % (p<0,05) than the same indicator in the group trained on the basis of the traditional most common methods.

Also, we have calculated the average grade of the level of mastering the swimming strokes obtained by each swimmer. The initial analysis of Table 3 shows that children with a hemiparetic form of cerebral palsy of the control group are better at mastering competitive swimming strokes than children with spastic diplegia.

Table 3
Comparison of the level of front crawl technique mastering on swimmers with different forms of cerebral palsy at the end of the experiment

Form of [1]CP	[2]CG (n=15)	[3]IG (n=15)
	mean ±[6]SD	mean ±[6]SD
[4]HF	3.7±0.2	4.1±0.2
[5]SPD	3.6±0.1	3.8±0.3

Note: [1]CP – cerebral palsy; [2]CG – control group; [3]IG – intervention group; [4]HF – hemiparetic form; [5]SPD – spastic diplegia, [6]SD – standard deviation

This difference is almost 3 %. The same tendency persists for children of the intervention group; the difference is about 7 % (p<0,05).

The coherence of the observers' opinions about the level of mastering the swimming stroke by the coefficient of concordance in the control group of children for the front crawl is equal to W=0.95 and in the intervention group of children –W= 0.97. As the values of the coefficient of concordance for both groups exceed 0.9 and close to 1, the obtained data testify the high degree of the consensus of the observers' opinion regarding the level of mastering the front crawl stroke by children with the consequences of cerebral palsy of the control and intervention groups.

The statistical reliability of the coefficient of concordance was estimated using Pearson's criterion $\div^2$. As $\chi_p^2 = 80.07 > \chi_\tau^2 = 29.14$ for the control group of children, and for the intervention group - $\chi_p^2 = 75.5 > \chi_\tau^2 = 27.69$, we have concluded that there is a statistical reliability of the coefficient of concordance and coherence of the observers' opinions.

The coefficient value of the front crawl swimming stroke of children of the intervention group during the implementation of the model has become significantly higher compared to the same coefficient value of children of the control group. For the front crawl stroke, this difference is 20 % (Table 4).

Table 4
The coefficient value of the front crawl swimming technique efficiency for children of control and intervention groups after the experiment (%)

Form of [1]CP	[2]CG (n=15)	[3]IG (n=15)	[6]U	?
	mean ±[7]SD	mean ±[7]SD		
[4]HF	29.8±4.1	40.1±5.4	3	<0.05
[5]SPD	31.2±4.6	36.7±4.9	11	<0.05
Total by group	30.3±4.2	37.8±5.5	24	<0.05

Note: [1]CP – cerebral palsy; [2]CG – control group; [3]IG – intervention group; [4]HF – hemiparetic form; [5]SD – spastic diplegia; [6]U – Mann–Whitney U-test, [7]SD – standard deviation

Discussion

Scientific researches by (Maniu, Maniu & Benga, 2013; Declerck, Feys & Daly, 2013; Vascakova, Kudlace & Barrett, 2015) are devoted to the initial swimming training for children with cerebral palsy. It has been established that the swimming instruction for such children is complicated by the existing physical and psychological characteristics and it is aimed primarily at physical rehabilitation, not sports training. We agree that the peculiarities of these children have a significant impact on the process of teaching the sports swimming stroke. Therefore, our research focuses on studying and solving this problem.

The results of our study clarify and supplement

existing data at the level of mastering the stroke of front crawl swimming for children with spastic forms of cerebral palsy (Moretto, Pelayo & Chollet, 1996; Balan, 2015; Varfolomeeva, Podolyaka, Panova, & Dobryakova, 2017; Pityn et al., 2018; Chan, Lee, & Hamilton, 2020). The conducted experiment has confirmed the results of the previuos scientific researches (Declerck, Feys & Daly, 2013; Jorgic et al., 2014) regarding the differences in the content of the training process with athletes of various forms of cerebral palsy (spastic diplegia, hemipartic form).

Theoretical aspects of the problem of using information technologies in the process of physical education and sports training are reflected in the works of many scientists (Ichikawa, Ohgi, Miyaji & Nomura, 2003; Ceseracciu et al., 2011; Moskalenko, Borysova, Sydorchuk & Liadska, 2014; Callaway, 2015; Iukhno, 2015). In these researches it has been noted that the use of modern information technologies can significantly improve the quality of the training process and, as a consequence, technical skills of the athletes. We have not found any computer programs targeting at people with disabilities. As we have noted in the previous studies (Bosko, 2016), in the preparation of swimmers with cerebral palsy, an important condition is to bear in mind the motor disturbance of an athlete and the biomechanical characteristics of the movements (Borges, Lara & Rodacki, 2017; Zhyrnov et al., 2017; Hruzevych et al., 2017), but we did not find any software products that correspond to this requirement.

The research conducted by the authors of the article makes it possible to state that nowadays there are practically no methods used to study the competitive swimming strokes to children with disabilities, and mainly we have found strokes for the hydrokinesiotherapy of children with cerebral palsy. Therefore, we have designed the pedagogical model for teaching the basic competitive swimming strokes to children with spastic forms of cerebral palsy, which is based on taking into account the motor disturbance of children and the kinematic characteristics of the swimming stroke of the qualified swimmers with cerebral palsy, and is grounded on the use of information technologies.

The results of our research can be used by coaches, swimming instructors, who work with children with spastic forms of cerebral palsy to teach the stroke of the front crawl swimming at the stage of initial sports training.

To boost the efficiency of proposed pedagogical model of teaching basic competitive swimming strokes we decided to develop a specific software «SwimCP» as a pprospect for further research. «SwimCP» is a teaching platform aimed at assisting the coaches who teach children with severe forms of cerebral palsy. The designed system would contain 4 tabs, in particular «Safety Technique», «Theoretical information about children with cerebral palsy», «Methodical recommendations for educational work with children with cerebral palsy», «Data Entry and Analysis». We suppose that «SwimCP» would give coaches the opportunity to automatically select an approximate complex of exercises taking into account the peculiarities of motor disturbance in accordance with the specific form of cerebral palsy.

Conclusions

The researchers have offered a wide range of computer programs for many directions of physical education and sports of healthy people, but there are a number of problems that prevent coaches to use these programs in full range, as they are not freely available and do not provide a swimming teaching to children with the consequences of cerebral palsy.

The pedagogical model of teaching the basic competitive swimming strokes to children with cerebral palsy, designed and presented by the authors, allows to optimize the process of technical training for the beginner swimmers, and its main means of implementation is the web-based information system «SwimCP», which promotes an effective swimming teaching at the initial stage of sports training through the selection and recommendation of a focused set of exercises for the training process, taking into account the peculiarities of motor disturbance in accordance with the specific form of cerebral palsy and the learning stage of motor actions.

The effectiveness of the proposed pedagogical model is confirmed by the observers' assessment and by determination of the coefficient value of the front crawl swimming stroke efficiency. ²t has been reliably confirmed that the level of mastering the swimming stroke of children who used this designed model was objectively higher in comparison with the same indicators of training related to the traditional method. The average difference in marks is 8 % (pÂ0.05) between the control and intervention groups of children with cerebral palsy during the process of mastering the stroke of the front crawl swimming. The coefficient of efficiency of stroke of the front crawl swimming for the

children of the intervention group as the result of the implementation of the pedagogical model has become significantly higher than in the control group (by 20 %).

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