IMPROVING SPORTS PERFORMANCE IN BREASTSTROKE SWIMMING THROUGH THE MEANS OF FITNESS

Narcis NEAGU[1], Nicoleta LEONTE[1*], Ofelia POPESCU[1], Iancu RĂCHITĂ[1]

[1] Politehnica University, Faculty of Medical Engineering, Bucharest, Romania
*Corresponding author: nicoleta_leonte@yahoo.com

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Abstract. *The improvement of sports performance in cadet swimmers is based on two types of training: specific (aquatic) physical training and non-specific (land-based) physical training. Considering that the swimming-specific effort is predominantly aerobic, strength development in cadet swimmers is a prerequisite for obtaining appropriate adaptation to effort and superior sports results in competitions. The purpose of this study is to develop a physical training programme purposely designed for cadet breaststroke swimmers (12-14 years old) using the specific means of fitness. The experiment was carried out from 20 January 2019 to 20 December 2019 on a sample of 24 cadet swimmers from the Dinamo School Sports Club (CSS) in Bucharest. The research subjects were distributed into two equal value groups, namely the experimental and control groups. Both groups were assessed for the 200-m event in the initial and final phases of the research. At the end of the experiment, higher values of the results were recorded for the experimental group compared to the control group. This highlights that the training programme applied to the experimental group has been more efficient due to the means used as well as their dosage. The methods and means used in the breaststroke-specific training programme guide the entire methodology of applying the independent variable. Following this research, the obtained results demonstrate that the independent variable of the study produces significant increases in physical training, which have been successfully transferred to the competitive events performed in the water environment.*

Keywords: *performance, breaststroke, fitness.*

Introduction

Achieving high-value sports results can no longer be conceived without the rationalisation, standardisation and optimisation of the entire training process according to well-established requirements for each level of training.

The training process in performance sports aims to constantly increase the exercise capacity in order to improve the adaptation of the body to a large amount of work per training lesson, but also to maintain the exercise intensity for as long as possible. Sports performance in breaststroke swimming is a multifactorial phenomenon that brings together energy systems, biomechanics, hydrodynamics, anthropometry and endurance parameters (Barbosa et al., 2008; Sadowski et al., 2012).

The complexity of optimising physical training entails the combined approach to motor skills, which is the most tempting idea, the core of the problem mainly seen in practical terms. Basically, everything is a matter of dosage, namely how much of the dominant motor skill is used and how it combines with the other skills according on the demands of the swimming stroke and the branch of events. Every sports performance is always, to a greater or lesser extent, a discovery of new ways to exploit the athlete’s potential and some specific means of training. Thus, Barbosa et al. (2010) considered it necessary to develop an analysis model for young swimmers’ performance based on biomechanical and energetic parameters, using the structural equation modelling. For biomechanical assessment, the above authors analysed the stroke length, stroke frequency and swimming velocity. Energy assessment included the stroke index, critical velocity and propulsive efficiency. In conclusion, the proposed model was appropriate to explain performance in young swimmers.

In sports training, there is a particular interest in the physical effort whose action involves the muscular and energetic systems, the transmission and processing of information causing a specific level of demand on the body, which has the effect of developing physical, functional, biochemical and psychological abilities up to certain limits.

Strength training is an essential element when trying to produce the best results. The athletes involved must follow a yearly plan designed to lead to top performance in major competitions. Thus, strength training is one of the key ingredients in establishing the physiological basis for high performance.

If general sports training has to be planned and periodised so as to ensure performance improvement from one phase to another, same thing is true for strength training. General sports skills and strength can be improved through various methods during training phases to create a final product, namely specific strength. Swimming involves a certain type of particular strength combinations, which must represent the physiological basis of performance. Thus, athletes can turn strength into a skill specific to the practiced sport by using training methods specific to the requirements of each training phase.

In swimming, strength is an essential attribute to produce the fastest acceleration possible and overcome water resistance. Thus, the involved strength actions must be executed repetitively and very quickly. In order to achieve the fastest acceleration, the development of maximum strength becomes crucial. Thus, the athlete's force is applied against a given resistance. The dominant energy system in this sport is aerobic endurance. Performance improvement results from increases in aerobic power, and strength training must be designed for this purpose. The key training ingredient for increasing long-term muscle endurance is the large number of repetitions performed uninterruptedly. For this, the specific strength training programme must relate to the continuity of training, where aerobic endurance is either dominant or an important component in achieving performance. (Bompa, 1999)

Numerous studies have shown the importance of developing strength and power in order to increase sports performance. Dry-land physical training is based on exercises that involve the muscle groups used in swimming, which simulate the movements performed in water with full range of motion and at a steady pace; the machines will be predominantly used in the supine position (Suciu, 2015).

Studies focused on the dry-land training of junior swimmers have reported positive effects, in the sense of increasing sports performance (Crowley et al., 2017; Sadowski et al., 2012; Girold et al., 2007; Suchomel et al., 2016).

Research conducted on swimmers aged between 13 and 14 years highlight the importance of using plyometric training, which, together with swimming-specific training, can have a positive impact on the swim start (Bishop et al., 2009).

In the literature, there is concrete evidence that supports the use of plyometric exercises, such as vertical jumps, to monitor and improve sports performance in young swimmers (Thng et al., 2019; Gencer et al., 2018). Also, the use of added resistance in strength training (parachute training) is recommended during specific workouts, provided it is performed close to maximum velocity (Schnitzler et al., 2011).

Given that fitness is a term assigned to a whole range of activities and states, the means by which it aims to achieve its objectives will be as appropriate as possible. There are a multitude of motor acts, exercises and structures of exercises whose final goal is to obtain good physical condition. In fitness, both specific and associated means are used.

To stimulate the increase of functional and morphological indices, to develop the overall exercise capacity of children's bodies and thus to ensure the energetic background for performance, additional training that uses means from various sports is also needed. If properly administered, this component of general training, which is called physical training, can become a facilitating factor for the improvement of recovery processes by alternating the exercise structure.

Fitness training should be classified according to the methods used to produce muscle tension. In the literature, strength training methods are sometimes classified according to the type of exercise used (isometric, isotonic, eccentric type, etc.). However, this classification should be retained as a taxonomy of strength exercises rather than training methods.

There are several methods to produce muscle tension:

- Maximal effort method – "with maximal loads"
- Submaximal effort method – "with nonmaximal loads"
- Repeated effort method – "with nonmaximal loads" until exhaustion; during the final repetitions, the muscle develops the maximum possible strength until exhaustion;
- Dynamic effort method – lifting a nonmaximal load with the highest possible velocity.

The possibility to choose a group of exercises for each workout but also to combine them is practically illimited. Experience shows that as the muscle becomes stronger, fewer motor units (and implicitly fewer muscle fibres) are needed to perform an exercise. Therefore, by frequently varying both the exercises and their order, the way of stimulating the engaged fibres will change, and the muscle will be better used.

Specialists do not recommend varying the exercises too often but to maintain the same schedule for 2 or 3 weeks before making changes.

The functional anatomical substrate involved in physical training guides the entire methodology of improving and making motor gestures appropriate to a swimming competition.

It is already known that strength training can be performed without significantly increasing muscle mass only in the first weeks of a new programme. This is largely due to neural factors or collective interactions between brain, nerves and muscles. The conclusion is that, by alternating the order of exercises during training, maximum results can be achieved for muscle strength and mass, and one can "juggle" with this variable to reach the upcoming objective.

Training intensity is undoubtedly the most important training variable, being the main stimulus for muscle growth and adaptation. Intensity can be defined either by the amount of lifted weight (as a percentage of 1 maximum repetition) or by training the muscle according to the percentage of its ability to contract and recover.

Obviously, overloading or increasing the time the muscle is under tension can generate situations in which growth hormones (IGF, testosterone, insulin) accelerate the movement of amino acids in muscle cells. The sooner this happens, the faster the increase in muscle strength and mass.

Training volume should be seen as the effort provided during a workout or the total weight lifted (expressed in kilograms). To measure volume, the weight lifted is multiplied by the number of reps and the number of sets. It can be noted that a large number of variables can be taken into account. However, generations of researchers have provided optimal parameters for the development of muscle mass. In this regard, a high training volume is recommended by specialists. History and experience have shown that repetitions within the range between 6 and 10 are best for increasing muscle mass and strength.

When designing fitness programmes, we should consider the following aspects: length of exercise, effectiveness of muscle activity with respect to the muscle groups engaged, speed of recovery after exercise.

The exercises used within the programmes should follow a methodical sequence, have a specified volume and be gradual in terms of intensity and complexity.

The break seems to be the training component that is given little attention despite its importance. However, the break has a direct impact on training intensity, training density and restoration of energy reserves at the level of a set, exercise, muscle group and the entire training.

- The break between sets – depends on the training volume and intensity. The sets of 8-12 repeats will need less energy recovery and therefore the breaks will be shorter, about 1 minute. On the other hand, muscles that work by set of 3-6 repeats deplete the ATP reserves and therefore longer breaks are needed, of about 2-3 minutes.
- The break between exercises – to avoid unnecessary training, a session should not last more than 50 minutes. After this period, glycogen reserves are depleted, and the muscle will use as fuel its own muscle tissue, which causes the undesirable catabolism. For this reason, the break between exercises should ensure minimum recovery, but it should not be too long either because time is limited. The optimal length between breaks is 2-3 minutes for exercises with sets of 8-12 repeats and up to 5 minutes for exercises with heavy sets of 3-6 repeats.
- The break between workouts – varies depending on each one’s level of training.

We can thus talk about two types of break:

1. the break between two training lessons, which depends on several factors such as the level of training, the intended objective, the training period.
2. the break between two training lessons for the same muscle group, which depends on several factors and lasts between 72 and 96 hours.

An essential criterion in selecting the means of training is their consistency with the level of demand on the athlete’s body during a competition. Therefore, the coefficients of effort and utility of the various means are established through mathematical processing and, depending on them, rankings are produced to prioritise the value of each means of training. In this regard, we aim to create an efficiency-based system that includes means for the development of physical training while taking into account the functional somatic characteristics of cadet swimmers, which would lead to increased sports performance in the 200-m breaststroke event for junior swimmers.

Assumptions

Starting from the assumption that dry-land physical training can be a decisive factor for the sports performance of junior swimmers, we will focus on organizing dry-land training in a systematic way characterised by the interplay between volume, intensity and complexity, thus reaching a maximum effect of dry-land training, which will directly reflect in the results achieved during the competitive swimming events.

By monitoring the training process of cadet swimmers over the last few years, we have noted that physical training is not properly addressed and sometimes is completely missing. Therefore, we, as adults and specialists in the field, need to create for them appropriate training programmes and adapt sports competitions to their age characteristics (Braneț, 2016). Creating an efficiency-based system that includes means for the development of physical training while taking into account the functional somatic features of cadet swimmers will increase the sports performance of junior swimmers in the 200-m breaststroke event.

Working hypothesis

Using fitness-specific means appropriate to the functional somatic characteristics of cadet swimmers will increase the sports performance of junior swimmers in the 200-m breaststroke event.

Research purpose

Developing methodological and practical structures to be applied in the training process, with the mark of our personal contribution, in order to accelerate the performance of cadet swimmers in the breaststroke event.

Methodology

Research methods

In order to know the complex issues related to the improvement of sports performance in juniors through sports programmes that include the means of fitness, we used the following research methods:

- documentation – achieved through an assiduous search for the latest and most reliable sources of information (books, journals, syllabi, iconographic and computerised sources, etc.). The bibliographic study helped us to build the theoretical background, as well as the entire course of the current research, using databases such as Google Scholar, EBSCO, ProQuest and SpringerLink;
- pedagogical observation – consisted in the systematic monitoring of motor actions and activities. In order to record the observed data, we used the system created by Sidentrop and Tannehill (2000) for developing teaching skills in physical education. The system involves assigning a time interval during which subjects are observed, and their activities are ranked. The system includes:

a) the framework or setting where the research is conducted;
b) the content of the training activity;
c) the response attitude of the participants in the experiment. (Pop & Ciomag, 2014)

- test method – aimed at collecting accurate information on motor characteristics, based on which predictions were made. In our study, the subjects were assessed (initially and finally) through the 200-m breaststroke event. By using this event, we aimed to provide a standardised situation with one task to achieve, the same for all tested subjects. The results were assessed by comparison with the results of the control group subjects in order to allow their ranking in relation to the average success of the reference group.
- statistical and mathematical method. In our research, the data obtained by measurements and tests were statistically processed, and the recorded indicators were as follows: arithmetic mean, standard deviation, mean difference, coefficient of variation, independent t-test, standard error of difference.
  Effect size – to highlight that the proposed training programme produces significant effects in terms of results achieved, the independent t-test was applied.
- graphical representation method – visually expresses the processed data and the research findings as ways of comparative analysis.

Participants and site of study

The experiment was carried out from 20 January 2019 to 20 December 2019 on a sample of 24 cadet swimmers certified at the Dinamo School Sports Club (CSS) in Bucharest. The subjects, aged between 12 and 14 years, were distributed into two equal value groups, namely the experimental and control groups. These groups were made up at random, allowing the assumption that they were equivalent at the beginning of the research. Both groups were assessed for the 200-m event in the initial and final phases of the research (Table 1).

The research took place at the swimming pool within the "Lia Manoliu" Sports Complex in Bucharest.

Table 1. *Duration and stages of the experiment*

Period	Activity
20.01.2019 – 25.01.2019	Initial test
1.02.2019 – 15.12.2019	Implementation of the training programme
16.12.2019 – 20.12.2019	Final test

Experimental design

This study falls into the category of comparative research conducted on two equivalent experimental groups, and the variables taken into account were the following:

- control group (CG), 12 subjects – the value of the independent variable was "zero";
- experimental group (EG), 12 subjects – an independent variable (V), namely an operational system using the means of fitness was applied to this group.

Purpose

For the purpose of this study, we classified the specific means according to the criterion of their effect on the indicators for physical training optimisation and implicitly on athletes' results in the 200 m breaststroke; circuit training was used as a methodological procedure (Table 2). Using the circuit method in the weight training lesson is advantageous due to the possibility of alternating the areas that need to be stimulated, thus facilitating faster recovery.

Themes

- Development of the physical training programme in order to achieve successful breaststroke technique for high-performance swimming through the means of fitness.
- Systematisation based on the efficiency criterion of fitness-specific means for the in-water and dry-land physical training in breaststroke technique, taking into account the somatic and functional features of junior swimmers.

Objectives

- Development of strength-speed endurance for the 200-m specific test
- Endurance-strength optimisation in the leg muscles
- Improvement of leg-stroke technique in leg-fatigue conditions
- Strength-endurance development of the arm muscles
- Increasing combined strength of the back muscles
- Improvement of abdominal muscle strength
- Increasing performance capacity in the mixed effort area

Table 2. *Means of fitness*

Means	Work time	Nature and duration of breaks	Number of sets	Intensity
Supine on the trolley, feet pushing against the base plate, 35^{o} tilt	2'45''	Active 2'	4	80%
Breaststroke arm work on the simulator	3'	Active 1'30''	4	85%
Supine, press push for thighs with 45-50 kg	2'45''	Active 2'	4	80%
Bench jumps	3'	Active 1'30''	4	80%
Helcometer pull-ups with 40 kg	2'45''	Active 2'	4	75%
Supine, vertical truck lifts	3'	Active 2'	4	80%
Jump squats	2'30''	Active 1'30''	4	75%
Breaststroke arm pull-ups with expander	3'	Active 1'30''	4	80%
Prone, trunk extension	3'	Active 1'30''	4	75%
Push-ups	60 repeats	Active 1'	6	70%

The methods and means used in the breaststroke-specific training programme guided the entire methodology of applying the independent variable. The experimental group followed the training programme proposed by us and introduced in the training process three times per week, while the control group performed the usual training programme.

Results

Through this study, we aim to find out where there are significant differences between the results of the two groups (experiment and control) at the end of the experimental intervention by using operational systems based on the means of fitness in order to improve the sports performance of junior swimmers in the 200-m breaststroke event.

The data obtained from the assessment were statistically processed using the following statistical indicators: arithmetic mean, standard deviation (SD) and coefficient of variation (CV). To verify the significance of mean differences, the independent t-test was applied (between the two groups), the significance threshold being established, in our case, for N = 12 for a p-value < 0.05. The statistical values mentioned above were calculated using the GraphPad program.

The results obtained by the control and experiment groups in the 200-m breaststroke event are shown in Table 3 and Table 4.

Table 3. *Results obtained by the control group in the 200-m breaststroke event*

Control group (Subjects)	Initial test (m.s)	Final test (m.s)
1	2.39	2.38
2	2.38	2.35
3	2.37	2.34
4	2.36	2.34
5	2.39	2.37
6	2.37	2.37
7	2.37	2.36
8	2.35	2.34
9	2.38	2.35
10	2.36	2.34
11	2.38	2.36
12	2.37	2.36

Table 4. *Results obtained by the experiment group in the 200-m breaststroke event*

Experiment group (Subjects)	Initial test (m.s)	Final test (m.s)
1	2.38	2.27
2	2.40	2.28
3	2.36	2.25
4	2.37	2.25
5	2.33	2.22
6	2.38	2.26
7	2.38	2.27
8	237	2.26
9	2.38	2.28
10	2.37	2.29
11	2.38	2.28
12	2.39	2.26

The results obtained in the 200-m breaststroke event highlight that the subjects of both research groups have recorded different values in the two tests (Table 5).

Table 5. *Average results of the two groups in the 200-m breaststroke event – Initial and final tests*

Test	Experiment group	Control group
Initial	2.374	2.372
Final	2.264	2.355

It can be noted that the experimental group subjects have obtained significant improvements throughout the research compared to the control group. The mean difference is 11% for the experimental group and 2% for the control group (Table 6).

Table 6. *Statistical indicators*

Statistical indicators	Results			
	Control group		Experimental group	
	Initial Test	Final Test	Initial Test	Final Test
Arithmetic mean	2.372	2.355	2.374	2.264
Median	2.37	2.36	2.38	2.27
Standard deviation	0.012	0.013	0.017	0.018
Maximum	2.39	2.380	2.4	2.29
Minimum	2.35	2.34	2.33	2.22
Mean difference	2%		11%	
t-test	t = 14.1974		p = 0.0001	

Data dispersion has the same homogeneous structure for both groups.

The result of verifying the statistical hypothesis with the t-test shows that the 95% confidence interval ranges between 0.078 and 0.104, and the mean difference is statistically significant at $p < 0.05$. Cohen's index (1.46) indicates a medium-to-large difference between the arithmetic means corresponding to the two tests. A percentage of 95% of the mean difference is due to the programmes used in the experiment. Thus, the research hypothesis is confirmed.

The results are graphically represented in Figure 1.

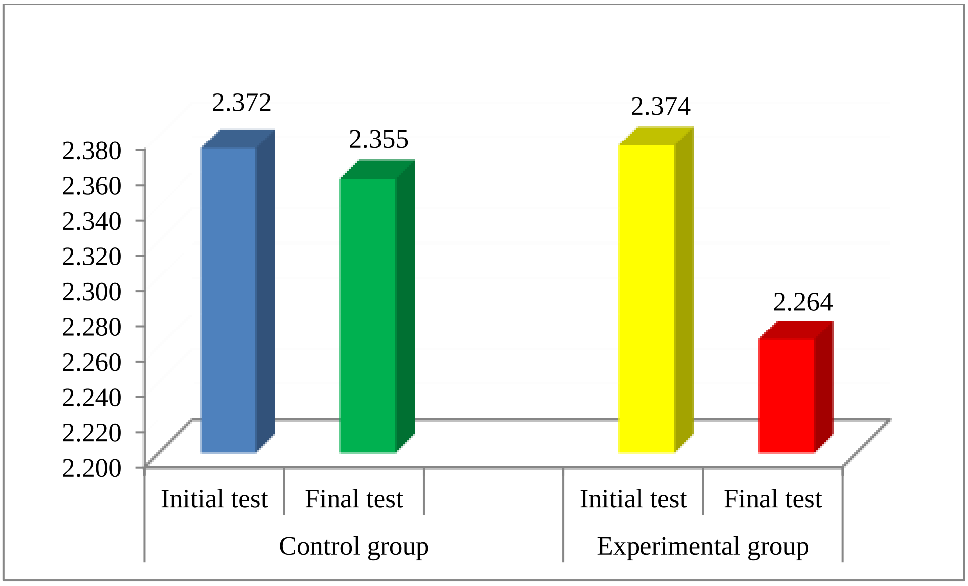

Figure 1. Average results of the two groups for the 200-m breaststroke event – Initial and final tests

Conclusion

The results obtained during the research as regards the development of dry-land training indices demonstrated the efficiency of the training process for the experimental group. In the initial test, the results of both groups were approximately equal. The development level of the dry-land physical training for the experimental group, with transfer to the competitive events and objectified by the results recorded in the tests applied, confirms both the appropriateness of the design and the methodology of developing and assessing the study carried out.

The heterogeneous nature of the motor phrase, of the motor action expressed during the competition involves engaging motor skills in different percentages, a reality that complicates the methodology of their improvement with a view to achieving sports performance.

Performing any motor act or action requires all the basic motor skills but in different proportions.

The training process in performance sports aims at constantly increasing the exercise capacity in order to develop the level of tolerating a larger amount of work per training lesson but also to maintain the exercise intensity for as long as possible.

By monitoring the training process of cadet swimmers over the last few years, we have noted that physical training is not properly addressed and sometimes is completely missing. Creating an efficiency-based system that includes means for the development of physical training while taking into account the functional somatic characteristics of cadet swimmers has increased the sports performance of junior swimmers in the 200-m breaststroke event.

The entire study demonstrates the definite progress of the experimental group compared to the control group due to the independent variable used in our research.

The use of operational systems in the training lessons has led us to state that fitness, through its means, contributes to the development of physical training, providing training models with a high degree of reliability.

Analysing the measured parameters with the help of statistical summary tables and comparing the obtained results, we could verify the efficiency of the means used in the physical training of junior swimmers participating in the experiment.

Following this research, the obtained results demonstrate that the independent variable of the study produces significant increases in physical training, which have been successfully transferred to the competitive events performed in the water environment.

Authors' Contributions

All authors have equally contributed to this study and should be considered as main authors.

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