Changes in stroke performance in 13-14 year old swimmers over an annual training cycle

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Abstract

Objective of study is to identify the dynamics of kinematic parameters of stroke technique in swimmers aged 13-14 years in the structure of the annual cycle.

Methods and structure of the study. The experiment involved 28 swimmers aged 13-14 years, I-II sports category. To assess the level of technical training, a method of computer video analysis of swimmers' movements during the 25 m breaststroke at maximum speed was used. In addition, the swimmers' anthropometric parameters were measured and the training loads were analyzed. The material was processed using mathematical statistics methods.

Results of the study and conclusions. In swimmers training according to the generally accepted program, only 7 of the 12 studied kinematic parameters showed reliable changes during the year. The observed increase in the parameters of the speed and acceleration of the hand movement in the pull-up phase indicates a decrease in the quality of the stroke, while the parameters of the speed and acceleration of the hand movement in the push-off phase did not show reliable changes. The detected discrepancies in the speed indicators in the main phases of the stroke may be the result of excessive power loads, in which the maximum effort is manifested at the beginning of the movement and negatively affects the formation of kinematic indicators in the pull-up phase, which in turn dictates the need to combine physical and technical training.

The pace of movements demonstrated a reliable decrease during the year, while the length of the "step" significantly increased only by the end of the year. The detected increase in the depth of immersion of the hand by the end of the year can be explained by the natural increase in anthropometric indicators. Maximum swimming speed demonstrated reliable dynamics only by the end of the year.

Thus, with the generally accepted version of the training process structure, the changes in the stroke structure detected during the year indicate an ineffective ratio of its components. This is evidenced by an increase in the speed and acceleration of the hand movement in the pull-up phase and the absence of the same in the push-off phase. This is also confirmed by an insufficient increase in the maximum swimming speed, which significantly improved only by the end of the year.

Keywords: *educational and training stage, dynamics of kinematic parameters, stroke technique, swimmers aged 13-14, annual cycle, experiment, qualification I-II sports category, technical training.*

Introduction. The educational and training stage of swimmers' preparation, covering the age of puberty, is one of the important ones in the formation and further improvement of the technique of the chosen swimming method [1, 5, 6, 7]. The main problem at this stage is the difficulty of realizing the increased strength capabilities of young swimmers [3]. The achieved level of strength abilities is not realized to the proper extent in water, since the specifics of the aquatic environment do not allow this. And only by improving intermuscular coordination, that is, the technique of movements in water, it is possible to increase the level of special training to a certain extent. All this indicates the need for a detailed study of the biomechanical characteristics of the stroke technique of young swimmers in order to identify the degree of its changes and find ways to combine physical and technical training.

Objective of the study is to identify the dynamics of the kinematic parameters of the stroke technique

in swimmers aged 13-14 years in the structure of the annual cycle.

Methods and structure of the study. The experiment involved 28 male swimmers aged 13-14, I-II sports category qualification, specializing in freestyle swimming. The stroke parameters were measured while swimming a 25 m distance using the front crawl at maximum speed. To assess the kinematic parameters of the stroke technique, computer video analysis was used, the essence of which was to film the swimmer's movements frontally and from the side with an underwater high-resolution Sony HD video camera, followed by processing the resulting video material in the Silicon Coach Pro program. Anthropometric indicators were measured with a stadiometer to measure the subjects' body length and a centimeter tape to measure the arm length. Training loads were analyzed regularly. Over the entire study period, 3 tests were conducted: at the beginning, middle and end of the annual cycle. The material was processed using mathematical statistics methods.

Results and conclusions. The training process of athletes was carried out in accordance with the Federal Standard of Sports Training in the sport of "swimming" (FSST) and the annual plan covering the autumn-winter and spring-summer periods. In the first half of the

Dynamics of kinematic parameters of the stroke in the annual cycle (x±m)

Indicators	Testing		
	1	2	3
Speed of hand movement in the grip phase (m/s)	0,604±0,01	0,609±0,01	0,613±0,01
p (t)	p_{1-2}>0,05 (0,35); p_{1-3}>0,05 (0,64); p_{2-3}>0,05 (0,28)		
Speed of movement of the hand in the pulling phase (m/s)	0,509±0,01	0,552±0,01	0,579±0,01
p (t)	p_{1-2}<0,01 (3,04); p_{1-3}<0,001 (4,95); p_{2-3}>0,05 (1,91)		
Speed of movement of the hand in the push-off phase (m/s)	1,952±0,02	1,957±0,01	1,961±0,01
p (t)	p_{1-2}>0,05 (0,35); p_{1-3}>0,05 (0,64); p_{2-3}>0,05 (0,28)		
Acceleration of hand movement in the grip phase (m/s^2)	-0,420±0,01	-0,425±0,01	-0,431±0,01
p (t)	p_{1-2}>0,05 (0,35); p_{1-3}>0,05 (0,78); p_{2-3}>0,05 (0,42)		
Acceleration of the wrist movement in the pull-up phase (m/s^2)	0,179±0,01	0,208±0,01	0,225±0,01
p (t)	p_{1-2}<0,05 (2,05); p_{1-3}<0,01 (3,25); p_{2-3}>0,05 (1,20)		
Acceleration of the hand movement in the push-off phase (m/s^2)	1,100±0,01	1,106±0,01	1,116±0,01
p (t)	p_{1-2}>0,05 (0,42); p_{1-3}>0,05 (1,13); p_{2-3}>0,05 (0,71)		
Length of the hand movement trajectory in the capture phase (m)	0,385±0,01	0,389±0,01	0,392±0,01
p (t)	p_{1-2}>0,05 (0,28); p_{1-3}>0,05 (0,49); p_{2-3}>0,05 (0,21)		
Length of the trajectory of the hand movement in the pull-up phase (m)	0,526±0,01	0,532±0,01	0,555±0,01
p (t)	p_{1-2}>0,05 (0,42); p_{1-3}<0,05 (2,05); p_{2-3}>0,05 (1,56)		
Length of the trajectory of the hand in the push-off phase (m)	0,200±0,01	0,205±0,01	0,209±0,01
p (t)	p_{1-2}>0,05 (0,35); p_{1-3}>0,05 (0,64); p_{2-3}>0,05 (0,28)		
Water speed (dp/min)	76,058±0,45	74,148±0,32	72,795±0,31
p (t)	p_{1-2}<0,01 (3,46); p_{1-3}<0,001 (5,97); p_{2-3}<0,01 (3,04)		
Step length (m)	1,331±0,01	1,360±0,01	1,376±0,01
p (t)	p_{1-2}>0,05 (2,05); p_{1-3}<0,01 (3,18); p_{2-3}<0,05 (3,04)		
Brush immersion depth (cm)	44,950±0,01	44,968±0,01	44,986±0,01
p (t)	p_{1-2}>0,05 (1,27); p_{1-3}<0,05 (2,55); p_{2-3}>0,05 (1,27)		
Maximum speed, m/s	1,841±0,01	1,863±0,01	1,885±0,01
p (t)	p_{1-2}>0,05(1,56); p_{1-3}<0,01 (3,11); p_{2-3}>0,05 (1,56)		

annual cycle, special attention in physical training was paid to aerobic (55%) and aerobic-strength (45%). In the second half of the annual cycle, the emphasis in the work was aimed at developing strength (60%) and speed-strength qualities (40%), while the volume of loads in the aerobic zone was significantly reduced. At the same time, 12% of the total training volume was allocated to technical training in the first half of the annual cycle and 10% in the second. The results of testing swimmers in the annual cycle are presented in the table.

As can be seen from the table, during the year only 7 out of 12 indicators showed reliable changes. At the same time, in the pull-up phase, which is involved in creating the support, there were changes towards an increase in the speed parameters of the stroke, which do not characterize the stroke as effective due to the fact that when performing this phase, the hand must use the laminar layer of water, taking turbulence outward.

However, as the results of this study showed, in athletes, the observed increase in the speed of the hand movement in the pull-up phase indicates a "breakthrough" of the laminar layer, provoking a decrease in the lifting force and an increase in wave (turbulent) resistance.

A decrease in the quality of the stroke in the pull-up phase is also indicated by a reliable increase in the acceleration parameter of the hand movement, which should be considered in unity with the speed of the hand movement due to their close relationship [2]. The only exception indicating positive changes in the pull-up phase is a reliable increase in the length of the trajectory of the hand movement, and only by the end of the year. In our opinion, the noted shortcomings are the result of excessive power loads, in which the maximum effort is manifested at the beginning of the movement and negatively affects the formation of kinematic indicators in the pull-up phase. This, in turn, dictates the need for adequate conjugation of physical and technical training.

The pull-up phase is the supporting part of the stroke, which predetermines the quality of the execution of the following push-off phase, however, the parameters of the speed and acceleration of the hand movement in the latter did not change reliably. In the push-off phase, the development of effort to achieve maximum swimming speed is due to the phenomenon of cavitation (performance of locomotion by the mover in conditions of a hydrodynamic flow vacuum), which creates even greater emphasis. Under these conditions, using the force of impulse transfer between the muscles, the hand performs a powerful final movement associated with the "overlap". However, as the results of this study showed, the absence of reliable changes in the indicators of the speed and acceleration of the hand movement in the push-off phase is probably associated with insufficiently effective implementation of special strength loads of athletes, which do not involve an accentuated effect on the phase structure of the stroke. That is, the final part of the stroke, the most significant for the propulsion of the cycle, is not performed effectively enough by the swimmers under study.

Another indicator, the rate of movement, demonstrated a reliable decrease during the year, which should be understood as a positive factor. At the same time, the length of the "step" significantly increased only by the end of the year. The rate of movement and the length of the "step" are criteria for the quality of the stroke and largely determine the level of technical training. The picture observed in the present study also indicates the ineffectiveness of changes in the components of the stroke. Earlier in our work, it was shown that for an effective ratio of the rate of movement and the length of the "step", it is advisable to use special strength-oriented means, therefore the discovered relationship of these parameters indicates the need to optimize strength-oriented exercises in the preparation of swimmers [2, 3, 4]. The detected increase in the depth of immersion of the hand can be associated with a natural increase in anthropometric indicators.

The integral indicator and criterion of the implementation efficiency of the technique is the maximum swimming speed [1, 2]. As the results of this study showed, this parameter demonstrated reliable dynamics only by the end of the year, although an earlier increase should have been expected.

Conclusion. Thus, with the generally accepted version of the training process structure, the changes in the stroke structure identified during the year indicate an ineffective ratio of its components. This is evidenced by an increase in the speed and acceleration of the hand movement in the pull-up phase and the absence of the same in the push-off phase. This is also confirmed by an insufficient increase in the maximum swimming speed, which reliably improves only by the end of the year.

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