The relationship between technical and physical fitness parameters in swimmers aged 13–14

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Abstract

Objective of the study is to determine the degree of influence of physical fitness on the kinematic and dynamic parameters of swimming technique in young swimmers aged 13-14.

Methods and structure of the study. To assess physical fitness, tests from the Federal Standard for Sports Training in Swimming for the training stage were used, in which 85 swimmers aged 13-14 and with I-II sports qualifications took part. Technical readiness was assessed based on kinematic and dynamic indicators. The data was processed using mathematical statistics methods.

Results and conclusions. The data obtained allows us to propose a new conceptual model of the relationship between the physical and technical preparedness of young swimmers, where strength and speed-strength qualities are the basic factors determining the potential for technical mastery. Coordination abilities perform a modulating function, optimising the realisation of strength potential. Flexibility and general endurance play a supporting role, the importance of which may increase at later stages of athletic development. The identified patterns are of practical importance for the construction of the training process. An emphasis on the development of strength and speed-strength qualities in combination with the improvement of intermuscular coordination may become a key direction for optimising training methods for 13-14-year-old swimmers.

Keywords: *physical fitness, technical readiness, regression analysis, kinematic parameters, dynamic parameters, physical qualities, young swimmers.*

Introduction. The modern system of sports training for young swimmers is based on the integration of physical and technical training, which allows them to achieve high results in competitions [2]. Physical qualities such as strength, endurance and coordination play a key role in the formation of technical skills [1]. However, despite a significant amount of research in this area, the relationship between specific physical indicators and swimming technique parameters remains understudied [2]. This is particularly relevant in youth sports, where the foundations for future achievements are laid.

For young swimmers aged 13-14, who are in the stage of actively developing motor skills and biomechanical stereotypes, the coach's understanding of these relationships is a key factor in optimising the training process. Despite the existence of individual studies devoted to both physical and technical training of young swimmers, the nature of the relationship between these types of training remains insufficiently studied [3, 7]. In particular, the influence of general and specific physical fitness parameters on the kinematic structure of the stroke is poorly understood. Filling this gap could contribute to the development of more effective training methods based on the individual characteristics of young athletes, which in the long term will minimise the risk of technical errors and improve performance during the specialised training stage.

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Methods and structure of the study. 85 young swimmers aged 13-14 with I-II sports qualifications took part in the analysis of technical preparedness, and kinematic and dynamic parameters were consid-

Table 1. Regression statistics for physical and technical fitness indicators for swimmers aged 13–14

Technical parameters	Coefficient	Standard error	T – stat.	p
1000 m run				
Kinematic	0,19	0,25	0,76	>0,05
Dynamic	0,60	0,35	1,71	>0,05
Medicine ball throw				
Kinematic	0,15	0,20	0,75	>0,05
Dynamic	0,02	0,05	0,40	>0,05
Twists				
Kinematic	1,50	1,60	0,94	>0,05
Dynamic	1,20	1,45	0,83	>0,05
Bend				
Kinematic	0,45	0,50	0,90	>0,05
Dynamic	0,40	0,45	0,89	>0,05
Push-ups				
Kinematic	0,55	0,18	3,06	<0,001
Dynamic	0,60	0,15	4,00	<0,001
Standing long jump				
Kinematic	0,30	0,12	2,50	<0,001
Dynamic	0,35	0,10	3,50	<0,001
Sliding				
Kinematic	0,25	0,08	3,13	<0,001
Dynamic	0,30	0,07	4,29	<0,001
3x10 m shuttle run				
Kinematic	0,20	0,07	2,86	<0,001
Dynamic	0,25	0,06	4,17	<0,001
Romberg test				
Kinematic	0,10	0,20	0,50	>0,05
Dynamic	0,05	0,25	0,20	>0,05
8x50 m using the basic technique				
Kinematic	0,40	0,15	2,67	<0,001
Dynamic	0,45	0,16	2,81	<0,001
Starting reaction speed				
Kinematic	0,08	0,15	0,53	>0,05
Dynamic	0,06	0,18	0,33	>0,05
Average competition speed				
Kinematic	0,50	0,18	2,78	<0,001
Dynamic	0,55	0,20	2,75	<0,001
Static strength when simulating rowing on land				
Kinematic	0,35	0,12	2,92	<0,001
Dynamic	0,40	0,13	3,08	<0,001
Absolute pulling strength				
Kinematic	0,45	0,12	3,75	<0,001
Dynamic	0,50	0,13	3,85	<0,001

ered. Computer video analysis, described in detail in the work of Arishin A.V. [1], was used to evaluate the kinematic parameters of the stroke technique.

A set of tests was used to assess physical fitness: general endurance – based on the results of a 1000 m run, strength – based on the number of push-ups in 30 seconds and the distance of a medicine ball throw, speed and strength – based on the results of a standing long jump and a 3x10 m shuttle run, flexibility – based on the results of a forward bend, special physical fitness – Romberg test, exercises with a gymnastic stick, 8x50 m swimming using the basic technique, start reaction speed, average competitive speed, static strength when simulating rowing on land, absolute pulling strength. Statistical data processing was performed using Statistics software with descriptive statistics, normality of distribution testing, and multiple regression analysis [6].

Results of the study and discussion. The data obtained demonstrate a marked differentiation in the influence of various physical qualities on the kinematic and dynamic characteristics of swimming technique in athletes aged 13–14. Regression analysis of physical and technical fitness indicators revealed a number of statistically significant correlations that can be used to optimise the training process (Table 1).

Physical fitness indicators assessed in push-up, standing long jump and gliding tests had the greatest impact on the kinematic and dynamic parameters of swimming technique ($p<0.05$). This indicates that the development of upper shoulder girdle muscle strength (push-ups), explosive leg muscle strength (jumping) and push-off strength when gliding in water play a key role in the technical development of young swimmers, which is consistent with previous studies emphasising the importance of strength training in swimming [1, 3].

Such a pronounced correlation is probably due to the critical importance of developing upper shoulder girdle, torso and leg muscle strength during puberty, when the muscle corset necessary for effective stroke movements is actively forming.

It should also be noted that the greatest prognostic value was demonstrated by the strength training indicators of swimmers, which exceed similar indicators obtained in the studies by Chen L. [4].

The results of tests such as the 1000 m run and the medicine ball throw did not show a significant effect on technical parameters ($p>0.05$), which may be due to their lower specificity for this sport. For example, long-distance running, although it develops general endurance, does not have a direct impact on stroke technique or body position in the water. Similarly, throwing a stuffed ball, which is aimed at developing the strength of the arms and torso but does not imitate rowing movements, has a weak correlation with the dynamic and kinematic parameters of swimming. These results are consistent with studies indicating the need for specialised exercises that are as close as possible to competitive activity [1, 2].

Analysis of speed and strength qualities revealed a linear relationship between standing long jump results and technical parameters ($p<0.001$), which contrasts with the logarithmic model described in the works of Smith A. [7]. This discrepancy can be explained by the use of more accurate instrumental methods of technique assessment in our study, as well as changes in modern training programmes that pay more attention to the development of explosive strength.

Of particular interest are the data related to average competitive speed ($p<0.001$). This confirms the hypothesis that technical preparedness, including stroke efficiency and coordination of movements, directly affects athletic performance. A similar pattern was observed for the 8×50 m freestyle test ($p<0.001$), which emphasises the importance of speed-strength endurance in swimming. The data obtained are consistent with studies that note that a combination of technical skill and physical fitness is a key factor for success in middle- and short-distance swimming [4, 5].

In addition, regression analysis revealed that some tests, such as the Romberg test and start reaction speed, did not show a significant correlation with technical parameters ($p>0.05$). This may be due to the fact that these indicators reflect specific aspects such as balance or reaction to the start signal, which, although important for competitive activity, do not directly influence swimming technique in its classical sense. This fact confirms the hypothesis about the predominant influence of coordination on the spatial-temporal organisation of movements in water [5].

The data obtained on flexibility indicators are also of particular interest. In contrast to the results of Williams et al. [8], our study did not reveal any statistically significant correlations between traditional flexibility tests and swimming technique parameters ($p>0.05$). This paradox can be explained by several factors: the use of different and insufficiently specific tests, the age characteristics of the subjects (puberty), or changes

in modern swimming techniques, which place fewer demands on maximum joint mobility.

Conclusions. Thus, the data obtained allows us to propose a new conceptual model of the relationship between the physical and technical preparedness of young swimmers, where strength and speed-strength qualities are the basic factors determining the potential for technical mastery. Coordination abilities perform a modulating function, optimising the realisation of strength potential. Flexibility and general endurance play a supporting role, the importance of which may increase at later stages of athletic development.

The identified patterns are of practical importance for the development of the training process. An emphasis on the development of strength and speed-strength qualities in combination with the improvement of intermuscular coordination may become a key direction for optimising training methods for 13-14-year-old swimmers.

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