Synergized physical and technical training model for 12-13-year-old swimmers: benefits for annual training cycle

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Abstract

Objective of the study was to test benefits of the new synergized physical and technical training service model for the 12-13-year-old swimmers within their annual training cycle.

Methods and structure of the study. We used in the study video replays to analyze the individual swimming techniques; dynamometry using a SwimForceTest system; and standard mathematical statistics toolkit for the test data processing. We sampled for a yearly training experiment the 12-13-year-old Class I swimmers (n=57) trained for the third year, and split them up into Reference Group (RG, n=38) and Experimental Group (EG, n=19). The RG was trained as required by the traditional system, and the EG trainings were complemented by the synergized physical and technical fitness model with controlled movement biomechanics in the gym/ aquatic practices, and special excellence workouts in every motor skill training.

Results and conclusion. The new synergized physical and technical training service model for the 12-13-year-old swimmers was found beneficial as verified by the significant progress of the EG versus RG in the strength, technical fitness and top swimming speed tests. The priority to the strength training elements in the new model helped develop more efficient stroke dynamics in the EG versus the RG. Special excellence elements geared to improve the movement kinematics and dynamics in the further practices are expected to yield further benefits for the synergized training service and competitive fitness of the trainees.

Keywords: *physical and technical training, junior swimmer, synergy, harmony, training tools, annual training cycle.*

Background. Competitive progress of the modern swimmers is known to largely depend on their physical and technical fitness [3, 4], and no wonder that most of the studies analyze the relevant training elements, although these analyses tend to be rather specific/ differentiated that means that they tend to select and develop special knowledge fields. On the other hand, it is the integrative and inclusive approaches that make it possible to address the issue or problem in a multisided manner to find new priorities for progress in every field on the whole and athletic training systems in particular [1].

The 12-13-year-olds entering pubertal development stage are considered by many specialists [2, 5] particularly sensitive to the strength training elements. We assumed in this context that efficiently synergized physical and technical training service with a special emphasis on specific training elements could be beneficial for competitive progress of junior swimmers.

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Results and discussion. To prioritize the key physical qualities, we first made a regression analysis of the physical and technical fitness indices to find the priority/ dominant (accounting for above 90% of the total) strength and speed qualities critical for an individual technical fitness. Furthermore, having analyzed many parameters of the modern swimming techniques using a statistical ROC-analysis, we found the key/ dominant kinematic and dynamic swimming techniques criteria including: pull-phase hand movement speed (HMSp); pull-phase hand movement strength (HMSt); hand movement pace; and the vertical hand reach (maximal depth). We used the top swimming speed as a benchmark ("gold standard") in the ROC analysis.

The EG training was designed to prudently combine aerobic, aerobic-anaerobic, strength, speed and speed-strength elements; with the swimming techniques progress secured by and tested in the stepped-up workouts. The pre-experimental tests in the annual training cycle found the groups virtually the same in the successive cycle timings (with the time variations rated at 44% and 46% in the EG and RG, respectively) – indicative of the unstable swimming techniques i.e. excessive variations of the propulsive elements in the movement cycles. Based on these test data, we designed the EG spring-summer trainings so as to step up the training elements on threshold of anaerobic metabolism combined with the controlled glycolytic elements; with the both workouts rated at no more than 4% of the monthly totals.

The pre-experimental tests, therefore, gave us a bifurcation point for revising the EG training system so as to complement it with special gym/ aquatic practices including those with VASA training machines to excel the stroke in every element, particularly in the high-speed swimming practices. The training exercises were selected and customized based on findings of the ROC analysis.

The post-experimental (post-annual training cycle) physical and technical fitness tests included digital swimming techniques video analyses with the swimming techniques dynamics ratings and repeated successive cycle timing tests for every swimming speed level (slow, threshold of anaerobic metabolism level and top). The post-experimental tests found that the EG made progress in the successive cycle timings versus the RG (with the successive cycle time variations rated at 4% and 40% in the EG and RG, respectively). Tables 1 and 2 hereunder give the group pre- versus post-experimental swimming techniques test data variations.

The synergized physical and technical fitness tools were tested beneficial as verified by the significant ($p<0.001$) progress of the EG versus RG in the dynamic swimming technique tests (particularly in the pull-phase strength and power and ground move strength): see Table 1. The tests showed high progresses in the propulsive elements of the stroke due to the EG trainings being complemented with special controlled strength workouts in gyms and water. It should be emphasized that the tests found no significant intergroup differences in the entry-phase strength and power – in disagreement with

Table 1. *Pre- versus post-experimental dynamic swimming technique test data variations ( )*

Dynamic test	Pre-experimental		Post-experimental	
	EG (n=19)	RG (n=38)	EG (n=19)	RG (n=38)
Entry-phase strength, N	144.92±4.00	143.84±3.71	158.68±5.21	157.90±5.73
	$U_{кр}$=399.0; p>0.05		$U_{кр}$=312.0; p>0.05	
Entry-phase power, W	63.48±18.10	63.11±16.41	80.82±12.47	80.42±10.88
	$U_{кр}$=344.0; p>0.05		$U_{кр}$=388.5; p>0.05	
Pull-phase strength, N	143.26±10.45	142.47±7.60	180.79±5.77	163.24±5.24
	$U_{кр}$=378.5; p>0.05		$U_{кр}$=15.0; p<0.001	
Pull-phase power, W	38.912±10.26	36.59±7.71	84.27±8.97	74.82±10.54
	$U_{крм}$423.5; p>0.05		$U_{кр}$=551.0; p<0.001	
Push-phase strength, N	136.11±4.76	136.26±4.33	172.95±8.47	156.82±8.25
	$U_{кр}$=367.0; p>0.05		$U_{кр}$=64.0; p<0.001	
Push-phase power, W	83.72±20.39	82.93±15.42	187.63±18.58	156.65±21.46
	$U_{кр}$=372.0; p>0.05		$U_{кр}$=93.5; p<0.001	
Ground move strength, W	100.39±2.95	99.98±1.92	102.54±3.38	99.93±3.25
	$U_{кр}$=395.5; p>0.05		$U_{кр}$=143.0; p<0.001	

Table 2. *Pre- versus post-experimental kinematic swimming techniques test data variations ( )*

Dynamic test	Pre-experimental		Post-experimental	
	EG (n=19)	RG (n=38)	EG (n=19)	RG (n=38)
Entry-phase hand speed, m/s	0.44±0.12	0.44±0.11	0.51±0.07	0.51±0.06
	$U_{кр=}$338.5; p>0.05		$U_{кр=}$379.5; p>0.05	
Pull-phase hand speed, m/s	0.27±0.06	0.27±0.05	0.41±0.05	0.52±0.064
	$U_{кр=}$375.5; p>0.05		$U_{кр=}$655.5; p<0.001	
Push-phase hand speed, m/s	0.64±0.13	0.63±0.17	1.09±0.10	1.00±0.12
	$U_{кр=}$365.5; p>0.05		$U_{кр=}$215.5; p<0.05	
Water pace, moves/ min	78.71±3.16	80.37±2.80	77.03±2.03	79.269±1.54
	$U_{кр=}$255.5; p>0.05		$U_{кр=}$613.5; p<0.001	
Ground pace, moves/ min	79.32±3.08	80.20±2.92	76.90±1.66	80.00±1.68
	$U_{кр=}$311.0; p>0.05		$U_{кр=}$651.5; p<0.001	
Cycle time, s	0.61±0.05	0.61±0.07	0.80±0.03	0.75±0.03
	$U_{кр=}$376.5; p>0.05		$U_{кр=}$63.5; p<0.001	
Stroke, time, s	0.4±0.05	0.40±0.07	0.67±0.057	0.61±0.05
	$U_{кр=}$376.5; p>0.05		$U_{кр=}$129.5; p<0.001	
Vertical hand reach, cm	39.04±2.13	38.80±1.55	41.12±1.29	42.41±1.58
	$U_{кр=}$380.5; p>0.05		$U_{кр=}$533.0 p<0.01	
Entry-phase trajectory, m	0.23±0.05	0.23±0.05	0.27±0.03	0.30±0.03
	$U_{кр=}$355.0; p>0.05		$U_{кр=}$561.5 p<0.001	
Pull-phase trajectory, m	0.53±0.07	0.51±0.08	0.72±0.02	0.67±0.03
	$U_{кр=}$406.0; p>0.05		$U_{кр=}$55.5 p<0.001	
Push-phase trajectory, m	0.24±0.17	0.26±0.09	0.33±0.02	0.22±0.05
	$U_{кр=}$251.0; p>0.05		$U_{кр=}$36.5 p<0.001	
Stroke length, m	1.26±0.07	1.26±0.09	1.39±0.02	1.3±0.03
	$U_{кр=}$396.0; p>0.05		$U_{кр=}$24.5 p<0.001	
Entry-phase hand acceleration, m /s²	0.10±0.11	0.11±0.11	-0.39±0.17	-0.38±0.16
	$U_{кр=}$325.0; p>0.05		$U_{кр=}$394.5 p>0.05	
Pull-phase hand acceleration, m /s²	0.14±0.82	0.12±0.64	0.21±0.48	0.20±0.36
	$U_{кр=}$305.0; p>0.05		$U_{кр=}$335.5 p>0.05	
Push-phase hand acceleration, m /s²	0.71±0.52	0.73±0.09	2.56±0.09	1.23±0.68
	$U_{кр=}$277.0; p>0.05		$U_{кр=}$37.5 p<0.001	
Top swimming speed, m/s	1.36±0.04	1.35±0.04	1.62±0.08	1.52±0.03
	$U_{кр=}$443.5; p>0.05		$U_{кр=}$51.0 p<0.001	

Daiki Koga et al. [6] who ranked this movement phase with the propulsive ones. We also found a few significant intergroup differences in the kinematic swimming technique test data: see Table 2.

The spatial performance tests found intergroup differences in the pull- and push-phase hand trajectories and strokes (p<0.001). The phase timing analysis found intergroup differences in the cycle times and stroke times (p<0.001) in favor of the EG, with the ground/ water movement paces tested significantly lower (p<0.001) in the EG. The hand speed tests found significant intergroup differences only in the pull and push phases. Despite the insignificant intergroup differences in the pull-phase accelerations, the pull-phase hand speed was tested significantly lower in the EG (p<0.001) that is indicative of the higher stroking efficiency. The top swimming speed is known to be indicative of the general individual physical and technical fitness. Note that the EG swimming speed was tested significantly above the RG in the post-experimental tests – that may be interpreted as indicative of the new synergized physical and technical training service model for the 12-13 year-old swimmers being beneficial.

Conclusion. The new synergized physical and technical training service model for the 12-13-year-old swimmers was found beneficial as verified by the significant progress of the EG versus RG in the strength, technical fitness and top swimming speed tests. The priority to the strength training elements in the new model helped develop more efficient stroke dynamics in the EG versus the RG. Special excellence elements geared to improve the movement kinematics and dynamics in the further practices are expected to yield further benefits for the synergized training service and competitive fitness of the trainees.

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