Influence of maximum stroke force and reduction in training volumes on athletic performance in swimming

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Abstract

Objective of the study was to reveal the influence of stroke force and narrowing of training volumes on sports results.

Methods and structure of the study. In the course of the experiment, changes in the magnitude of muscle strength during the period of contraction were determined in 17 male swimmers of the highest qualification. Studies were conducted before, during and after the 14-day constriction. Two types of tests were used: on land and in water. On land, using the "biokinetic bench for swimming" simulator, the maximum stroke power was measured. The maximum hand strength was measured at various hand speeds. The simulator allows you to accurately simulate the stroke movements of the hands when swimming freestyle or butterfly, exercises are performed at a given speed. The stroke power value was determined by dividing the total amount of load by the time of one stroke.

Results and conclusions. The results of tests on the biokinetic bench and swimming power measurements showed that swimmers can achieve higher peak power with proper training planning. Recent research data has shown a close relationship between biokinetic strength and sprint speed (freestyle swimming speed). The improvement in the results of swimmers' performances after the period of narrowing was also confirmed by the improvement in performance when performing exercises on the simulator. This means that the strength of the stroke affects the performance.

Keywords: *stroke force, biokinetic force, tapering period, stroke power, swimming, sports result.*

Introduction. The swimmer's swimming speed, to the greatest extent, depends on the magnitude of the maximum stroke force, which, in fact, determines the efficiency of the athlete's work in swimming. Since 1970, coaching staff have been analyzing video footage of national and international competitions to understand what separates the winners from the losers. One metric stays the same: faster swimmers take fewer strokes over the course, at the expense of maximum stroke power. Prolonged intensity of the load leads to a decrease in muscle strength at certain stages, and consequently, results. In order for swimmers to be at the peak of their sports form for the competitive period, large training volumes are reduced (on average, 2-3 weeks before the performances). Despite the fact that this reduction is practiced in many sports, there is little data on the physical changes that occur during this period in the body, on the effect of narrowing on athletic performance. [1,2,3] The reason why many cannot find the answer to the question of how to improve your time or how to move to a new level of sportsmanship, is not a lack of information in general, but, most likely, the lack of systematized information. As one knows, long-term intensity of the load leads to a decrease in the result at certain stages of muscle strength, and, consequently, the overall results.

Objective of the study was to reveal the influence of stroke force and narrowing of training volumes on sports results.

Methods and structure of the study. In the course of the study, changes in the magnitude of muscle strength during the period of contraction were determined in 17 male swimmers of the highest qualification. Studies were conducted before, during and after the 14-day tapering. Two types of tests were used: on land and in water. On land, using the "biokinetic swimming bench" simulator, the maximum value of the power of hand muscle movements was measured. This indicator was also studied during the test in water: each athlete must swim 200 m at a given speed, which was 90% of the maximum speed. All subjects trained daily for 5 months prior to the study. On average, they swam 9 km per day for four weeks. Approximately 75% of the sessions consisted of high intensity interval swimming. During the tapering (14 days), the total volume decreased daily from 7500 m (on the 1st day) to 3500 (on the 13th day); swimmers did not train on days 5 and 7. For comparison, the best result of each swimmer was taken before and after the reduction. The maximum stroke force was measured at different arm speeds using a biokinetic swimming bench. This simulator allows one to accurately simulate the stroke movements of the hands when swimming freestyle or butterfly, and the exercises were performed at a given speed. The force value was determined by dividing the total amount of load by the duration of one stroke.

The simulator has been modified to be used as an in-water test to measure the athlete's power of movement. To do this, a stainless-steel cable was attached to the control mechanism of the bench, connected to a special repellent device; on the other hand, the cable ended in a belt that was fastened to the swimmer. The speed switch on the simulator was set to a point at which the subject moved at a speed of approximately 1 m/s. If the speed increased, the cable would stretch and slow down the swimmer's speed. At the same time, the athlete swam a distance of no more than 10 m, and only the magnitude of the force was measured. The next test was also carried out in the water - the swimmer overcame a distance of 200 m at a speed of 90% of the maximum speed. The power of the swimmer's movements in the water was determined. At the same time, he/she had to swim in the way in which he/she specializes, and maintain a certain pace (with the help of signal lights at the bottom of the pool). After a 5-minute rest, blood samples were taken for lactic acid and pH, PCO2 and PO2. HCO3 was also calculated by the Andersen method. Heart rate was recorded during the recovery period.

Tests on the simulator and to determine the power were carried out on the 1st day of tapering and the next day after the competition. The test for samples of lactic acid and other components of the acid balance was carried out on the 1st and 7th days of tapering and the next after the competition.

Results of the study and their discussion. All swimmers improved their athletic performance after the study (Table 1). Regardless of the length of the course (from 50 m to 1500 m) and swimming methods, the results (compared to the best in the season) were improved by 2.2 - 4.6% (average value - 3.1%). Thus, there are differences between the periods before and after the tapering.

Due to the reduction in the volume of the training load, the values of the power of movements increased significantly during both tests: on land - 17.7% in water - 24.6%.

The 200-meter swimming data are presented in Table 2. Although the level of lactic acid in the venous blood was slightly reduced in the period after constriction, the other values (pH, HCO3, heart rate recovery time) remained unchanged.

Table 1. *Swimmers' performance before and after a 2-week reduced volume training period*

Swimming Style	Distance (meters)	Before Tapering	After Tapering	Changes (%)
Freestyle	50	22,9	22,34	-2,5
	100	49,83	48,76	-2,2
	200	1.48,38	1.44,38	-3,7
	400	4.55,06	4.45,46	-3,3
	1500	17.06,42	16.28,24	-3,7
Breaststroke	100	1.03,28	1.01,29	-3,1
	200	2.20,84	2.15,49	-3,8
Backstroke	100	1.03,28	1.01,29	-3,1
	200	2.20,84	2.15,49	-3,8
Butterfly	100	53,44	52,16	-2,4
	200	2.00,16	1.57,56	-2,2
Medley	200	2.10,86	2.04,80	-4,6
	400	4.31,37	4.23,85	-2,8

Table 2. *Changes in acid balance and heart rate recovery time after swimming a distance at a steady pace*

Day of the taper period	Distance travel time (200 m)	Lactic acid level (mmol/l)	pH	HCO_3	Heart Rate
1st	126±4,1	10,1±1.1	7,125±0,040	16,1±0,86	124±5
7th	126±4,6	9,6±4,6	7,114±0,084	16,1±0,84	123±6
15th	125±4,2	8,8±0,9	7,148±0,023	17,2±1,17	128±9

Swimmers complained of extreme fatigue and inability to train during the tapering period, but experienced a significant increase in strength during the final competition.

During the tapering period, there were no changes in the acid balance as a result of physical activity, but a significant increase in the level of power of movements was noted (when performing tests). Results improved by an average of 3.1%.

Recent research data has shown a close relationship between biokinetic strength and sprint speed (freestyle swimming speed). The improvement in the results of swimmers' performances after the tapering period was also confirmed by the improvement in performance when performing exercises on the simulator. This means that the force of the stroke affects the performance.

Conclusions. The results of tests on the biokinetic bench machine to measure the stroke power in swimming found that the best sprinters can achieve higher peak power than swimmers who show lower times in sprint distances. An increase in power level of 8.6% corresponds to a 2.8% increase in maximum speed, which is equivalent to a 3.1% improvement in race swim time (due to an increase in muscle strength).

Research has shown that swimmers experienced significant decreases in muscle strength and power levels during intense training. At the same time, swimmers specializing in long distances, after a large training load, had an insufficiently high level of "explosive" strength, which was restored after a certain period of rest. Thus, repeated days of high-intensity training help prevent an athlete from performing at or near peak, which can be achieved by reducing physical stress.

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