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Original Article

Features of the development of physical qualities of water polo players

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Abstract:
Application of power training exercises that are similar in structure and composition to competitive acts of water polo players and their purposeful use for developing power endurance, ultimate speed and explosive power ensure their greatest development.
It has been recognized that the most effective is the use of speed training exercises in the middle of the training session. In water polo training the practice of developing speed skills at the end of training session is the least effective. Combination of speed qualities training variants at different parts of training session throughout the year-round cycle of training adds to the positive effect of speed qualification of water polo players in general.
The experimental program of strength training of qualified water polo players, which provided purposeful development of strength capabilities (maximum, speed, explosive strength and strength endurance) by applying specific exercises, which correspond to features of competitive activity of water polo players, indicated its effectiveness in the main experiment.
In a result of experimental program implementation of strength training of experimental group athletes in comparison with the control group, significant improvements ($p < 0.05$) according to strength rated were occurred.
The experimental program of strength training of qualified water polo players, which provided testing of expediency of structuring use of speed exercises within the training sessions (at the beginning, at mid and in the end of the main part of training) also has shown effectiveness in both previous and in main experiments.
The most effective for the development of speed qualities of skilled water polo players is the use of high-speed swimming exercises in the second third of the main part of training session.
Key words: water polo players, speed training, power training, water polo, physical qualities

Introduction

Implementation of general theoretic approaches and principles of sport training system in the training process management is one of the urgent issues of modern sport. In water polo practice main coaches' and athletes attention is mainly concentrated on game's tactics and technique improvement. Development of the important water polo players' physical qualities is mainly unsystematic and is accomplished during technical and tactical preparation. Physical fitness is the basis for top-level technique and gaming tactics implementation. It becomes more important with sporting mastery growth when technical and tactical actions are perfectly studied.

The issues of highly qualified athletes physical preparation development, in particular power and speed training was deeply analyzed by the experts in specialized literature (Lynec, 1994; Platonov, 2004). Simultaneously multiple researches concerning training process planning were conducted (Platonov, 1995, 2000). These researches were mostly concerned by planning macro, meso and microcycles of trainings. Issues concerning development of athletes physical qualities during separate training session are insufficiently studied. Moreover experts disagree on the advisability of separate physical qualities development during different parts of the training session (Kaunsilmen 1982; Makarenko 1992; Platonov, 1992. 2000).

We haven't revealed any scientific researches concerning features of water polo players' physical qualities development during the training session in the available scientific literature. At the same time authors of many handbooks and scientific editions on sport theory (Bulgakova, 2001; Lynec 1994; Platonov, 1995) present data persuading in the necessity of athletes speed qualities development at the beginning of training session. This is explained by physiological features of human nervous system and biochemical indices of human muscle activity (Volkov, 1990; Korobeynikov, 2008; Pavlik, 2005; Platonov, 1992). Coaches of the qualified water polo teams traditionally stick to these rules. Lately new researches appeared (Makarenko, 1992; Platonov, 1992,

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2000) concerning possibility and expediency of speed qualities development in the end of training session after durable aerobic workout. We consider that other variants of speed qualities development during the training session of qualified water polo players exist. This issue requires additional research.

Power qualities development in qualified water polo players is conducted in traditional and standard manner adopted from other sports. These are actually general physical training exercises (Poproshaev, 2006). These are in particular exercises with bar, balls, rubber bands etc. Still specific of strength usage by water polo players during the competition isn't taken into consideration. This fact motivates to search new methods of water polo players' power abilities development that would match water polo specifics and establish their efficiency.

Material & methods

Researches were conducted in two stages. Water polo players from Lviv team "Dynamo" participated in the research. They were randomly divided into two groups control group (13 people) and experimental group (13 people). The experiment duration was 4 weeks and on its first stage changes in power fitness indices were researched in control and experimental groups. Experiment was cross-group meaning that each selected group was in role of control and experimental in its turn (2 weeks each). Control group trained according to traditional methods and the experimental according to our elaborated methods.

Second stage containing 3 microcycles was aimed at water polo players speed preparation research.

In the first microcycle sportsmen of the research group underwent sprinter loads at the beginning of training, in the second – in the middle part, and in the third – in the end of training session. Duration of every microcycle was 6 days and they were divided by recovery microcycles. Methods of the research: theoretic analysis and generalization of scientific-theoretical literature data and empirical researches materials, pedagogical observation, pedagogical experiment, separate methods of obtaining empirical data (measuring pull power in water and on land, wrist power, throw distance on land and in water, jumping height on land and in water, acceleration of ball flight during the throw, measuring time of segments swimming), mathematical statistics methods.

Aim of the work was to elaborate a program of targeted development of qualified water polo players power and speed qualities development;

Tasks.

1. Find out main theoretic and methodic principles of qualified water polo players power and speed qualities and their adoption in training process.
2. Determine the efficiency of methods of targeted qualified water polo players power qualities development.
3. Elaborate the program for water polo players power qualities improvement.
4. Determine comparative efficiency of building speed-directed training sessions.
5. Experimentally check the efficiency of author program on improving power and speed qualities of the qualified water polo players.

Methods of the research: theoretic analysis and generalization of scientific-theoretical literature data and empirical researches materials, pedagogical observation, pedagogical experiment, separate methods of obtaining empirical data (measuring pull power in water and on land, wrist power, throw distance on land and in water, jumping height on land and in water, acceleration of ball flight during the throw, measuring time of segments swimming), mathematical statistics methods.

To control the water polo players' speed and power physical properties (as told in Table 1) we have used the tests recommended by the authors (Platonov, 2000; Poproshaev, 2006).

Table 1. Tests to determine the level of speed and power qualities of qualified water polo players

N	Type of tests	Tested quality	Method of tests	Attempts
1	Maximum thrust on land (kg)	strength	Dynamometry	3
2	Acceleration of the ball at the throw (m/sec2)	strength	Speedometer	6
3	A throw of the ball on takeoff distance (m)	strength	Longimetry	3
4	The left and right dynamometry (kg)	strength	Carpal dynamometry	2
5	A standing high jump (cm)	explosive power	Abalakov's method	3
6	Maximum thrust at the start out of water (kg)	strength	Dynamometry	1
7	Thrust at the water polo start (kg)	strength	Dynamometry	1
8	A throw of the water polo ball out of water at distance (m)	strength	Longimetry	3
9	Maximum jumping out of water (m)	strength	Longimetry	3
10	Maximum thrust at 45s swimming (kg)	strength	Dynamometry	1
11	Crawl 50m, start from the platform (sec)	speed	Chronometry	1
12	Crawl 50m with dribbling (sec)	speed	Chronometry	1
13	Crawl 25, start from the platform (sec)	speed	Chronometry	1
14	Crawl 25, start in water (sec)	speed	Chronometry	1

15	Crawl 20, start in water (sec)	speed	Chronometry	1
16	Crawl 15, start in water (sec)	speed	Chronometry	1
17	Crawl 10, start in water (sec)	speed	Chronometry	1
18	Swimming, 5x3 crawl between the goal bars	speed	Chronometry	1

The control exercises were performed after recovery microcycle. The indices records were made during one training session. and enabled to determine the necessary parameters impartially.

Tests were performed separately for power and speed characteristics. First we studied power indices. Originally control exercises on land and in water were performed. The water polo players performed control exercises with an interval from rest to fully recover.

The defining of speed preparedness indices was carried out the same way. It must be emphasized that the speed control tasks were performed by the water polo players individually, which allowed objectively to assess the athlete's level of speed preparedness. Such method of the research arrangement allowed without undue loss of time to achieve full recovery of athletes.

The teaching experiment was characterized two-stage conduct. The water polo players of "Dynamo" (Lviv) - Champion and winner of the Cup of Ukraine 2014 (26 qualified athletes). Among them 14 masters of sport and 12 candidates for master of sports including candidates and members of the national team of Ukraine who were randomly assigned to the control CG (13 people) and tested TG (13 people) group. Age of the athletes ranged from 18 to 30. The training process took place at the sports complex "Dynamo". Training was carried out 6 times a week twice a day, the seventh day - recovery microcycle.

The experiment duration was 4 weeks and on its first stage changes in power fitness indices were researched in control and experimental groups. Experiment was cross-group meaning that each selected group was in role of control and experimental in its turn (2 weeks each). Control group trained according to traditional methods and the experimental according to our elaborated methods.

Second stage containing 3 microcycles was aimed at water polo players speed preparation research.

In the first microcycle sportsmen of the research group underwent sprinter loads at the beginning of training, in the second – in the middle part, and in the third – in the end of training session. Duration of every microcycle was 6 days and they were divided by recovery microcycles.

Results

No significant difference in the indices of power fitness in athletes of control and research groups was revealed at the beginning of the experiment ($p>0,05$).

After conducting the first stage of the experiment we revealed significant growth ($p<0,05$) in power indices of experimental group in comparison to control. Thus increase of maximum pull power on land made 2,13 % (47,6 kg ±1,24) in control group and 8,83 % (51,6 kg ±1,43) in the experimental, distance of the ball throw on land in control – 1,7% (37,4 cm ±0,56) and in experimental – 7,45% (39,2 cm ±0.65); indices of right hand wrist power dynamics – 1,6% (51,4 kg ±1,24) in control and 7,4% (54,6 kg ±0.95) - in experimental; indices of jumping up – 1,58% (45,75 cm ± 1,14) in control and 4,18% (49,64 cm ±1,42) in experimental; ball acceleration indices 1,5% (125,0 m/s ± 4.27) in control and 8,7% (136,88 m/s ±3.66) in experimental.

Tests determining maximum pull power while starting in the water and maximum pull power in water are considered one of the most informative indices for determining power fitness and durability of the water polo players. Significant growth of these criteria was analogously ($p<0,05$) observed in experimental group athletes 10,65 kg ±0,4, T % – 1,73% in control, 11,68 kg ± 0,27, T % – 5,8% - experimental and 16,91 kg ± 0,38, T % – 1,78% - control, 17,95 kg ± 0,3, T % – 4,1% -experimental accordingly.

It's well-known that players' effectiveness is determined by scored balls number. Power is considered one of the throw quality indicators. Therefore we used special test for determining ball throw distance in water during the pedagogic experiment. Results improvement is probably ($p<0,05$) higher in the experimental group (27,7 m ± 0,24,T % - 4,83%) in comparison to control group (26,61 m ± 0,27,T % - 1,5%).

Height of jumping out of the water is a specific test for determining the development level of lower limbs power. Comparison of these indices in water polo players of control and experimental groups shows that they probably improved ($p<0,05$) in the experimental group representatives. Growth rate made 1,38 m ± 0,02, T % - 5,8% in the experimental group and 1,32 m ± 0,01, T % - 2,6% in the control group.

According to pedagogic experiment data only left hand dynamometry indices didn't demonstrate any probable difference ($p>0,05$) in control and experimental groups' representatives. While it should be mentioned that more expressed increase of these results was observed in experimental group's representatives (47,9 kg ± 1,07, T % - 4,1%) in comparison to control group (46,83 kg ± 1,69, T % - 1,4%).

Second stage of determining the elaborated method efficiency of qualified water polo players' power training within pedagogic experiment included cross-experiment. Testing was conducted by analogous indices. Results of control indices growth rate in experimental and control group representatives after II stage of power fitness research were analogous (as told in Table 2).

Table 2. *Indices of results growth on the second research stage*

Power fitness indices	Control group	Experimental group
	Rate of increase (%)	Rate of increase (%)
Maximal pull power on land (kg)	2,2	9,3
Distance of ball throw on land (meter)	1,6	4,2
Right hand wrist dynamometry (kg)	1,4	7,3
Left hand wrist dynamometry (kg)	1,4	4,2
Height of jumping up from the spot (cm)	1,36	5,9
Maximal pull power at starting in water (kg)	0,9	6,7
Acceleration of ball flight at throw on land (meter-sec2)	1,46	4,68
Maximum pull power in water during 45 seconds of swimming (kg)	1,57	6,42
Ball throw for distance in water (meter)	1,83	6,31
Jumping out from the water (meter)	2,12	5,85

According to experimental results of qualified water polo players speed preparation no probable difference was revealed ($p>0,05$) concerning indices of speed preparation in control and experimental group representatives after first training cycle. This happened because the researched groups trained according to traditional method.

Cardinal differences were observed in the second training microcycle. Indices testing result analysis showed significant differences in middle indices and their growth in favor of the research group. Statistical verification of such differences demonstrated their certainty at $p<0,05$. During initial testing no significant changes between control and experimental groups was revealed ($p>0,05$). According to results obtained in the end of the II microcycle such changes were credible by all the indices.

Indices of 10 meter crawl swimming with starting in water showed the highest increase in the experimental group water polo players 4,68 s ± 0,07, T % - 5,98% and in control group only -4,96 s ± 0,1, T % - 1,85%. Experts consider swimming 5*3 in keeper swimming result the most informative for speed preparation of the attacking players. In our experiment this result was significantly improved in experimental group athletes14,79 s ± 0,25, T % - 5,1%, and in control group it showed 15,49 s ± 0,21, T % - 0,73% growth rate.

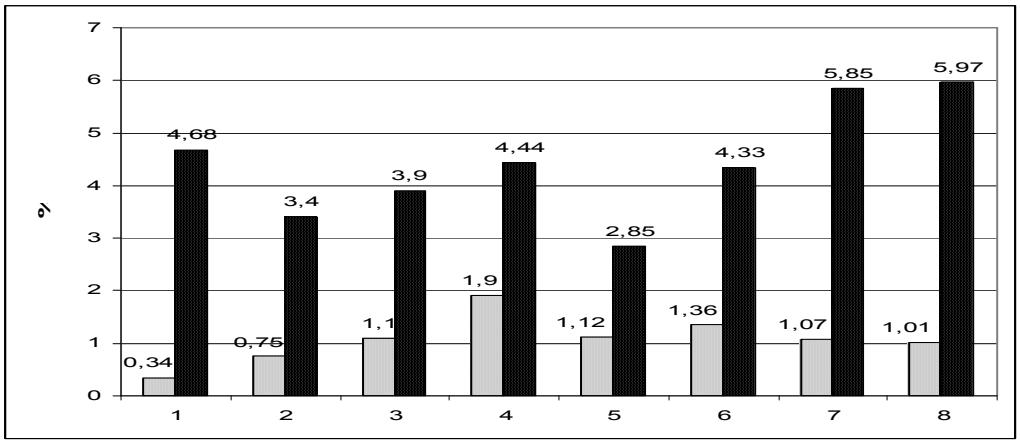
Large differences in indices growth rates in experimental and control groups was observed in swimming crawl 20 and 50 meters indices with start from water. Changes in these indices in control and research groups made 9,83 s ± 0,12, T % -1,6% an 9,51 s ± 0,008, T % - 4,9 % for 20 meter swim; 31,53 s ± 0,34 - 1% and 30,27 s ± 0,31 - 4,6% for 50 meter swim accordingly.

Almost similar growth indices in control and experimental groups' athletes were stated in the following speed fitness indices: speed 50 meter crawl swim with start from table – 4,09% (28,53±0,36) and 25 meter crawl swim with start from water – 3,9% (12,6 s ± 0,09). Control group indices were – 0,96% (29,54 s ± 0,32) and 2,03% (12,92 s ± 0,12).

In 25 meter crawl swim with start from water average athletes results growth made 13,2 s ± 0,1, T % - 3,4% in experimental and 13,52 s ± 0,1, T % - 0,99% in control group. This indicator fully demonstrates water polo players' ability to speed contact actions. While competitions are really fast the mentioned indices are crucial for victory in modern water polo. 15 meter crawl swim result has the lowest growth among all the experimental group sportsmen indices – 6,86 s ± 0,06,T % - and in control group it showed 7,22 s ± 0,11,T % - 1,19% growth rate.

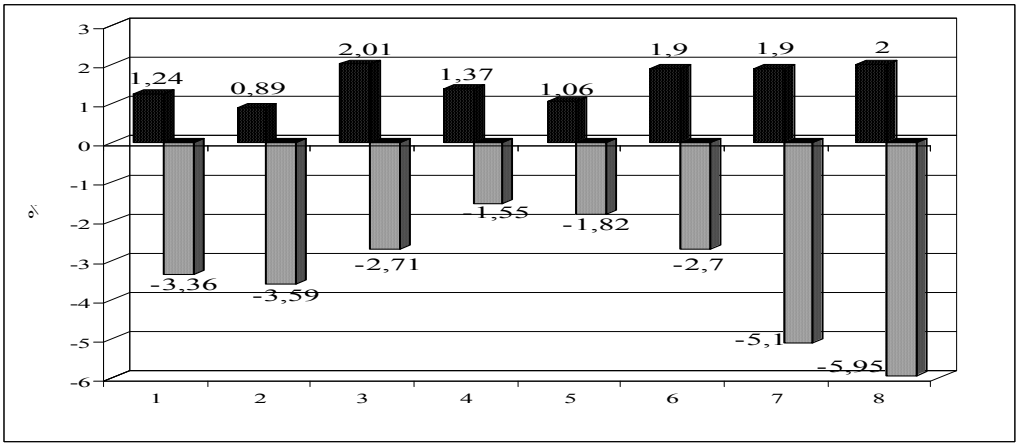
After the third microcycle speed qualities were developed in the end of the training session. All the indices of the researched indices in experimental group water polo players underwent probable decrease of the results in comparison with control group and athletes own results in the previous training microcycles ($p<0,05$). 10 meter crawl swim results with start from water worsened by 6,12%; 15 meter crawl by 5,21%; 5*3 crawl keeper swim – by 5,2%; 50 meter crawl with start from table – by 4,97 %; 50 meter crawl with start from water – by 3,95 %; 20 meter crawl with start from water – by 3,62%; 25 meter crawl with start from water – by 3,59 %; 25 meter crawl with start from table – by 1,81 %. At the same time control group representatives had results increase within 0,94%-up to 2,55 %.

We obtained analogous results of testing in three microcycles before II tour of the competition. Moderate increase of the researched indices was noted after the first training microcycle (traditional training). Accordingly after the second microcycle analogous growth rates of the results were observed in the experimental group. And after the third microcycle results worsened (Fig. 1, 2).



Control exercises

Fig. 1. Indices of qualified water polo players speed preparation growth rate after second microcycle of the second tour



Control exercises

Fig. 2. Indices of qualified water polo players speed preparation growth rate after third microcycle of the second tour:

1 - 5*3 crawl swim in the keeper; 2 - 50 m crawl swim with start from table; 3 - 50 m crawl swim with start in water; 4 - 25 m crawl swim with start from table; 5 - 25 m crawl swim with start from water; 6 - 20 m crawl swim with start from water; 7 - 15 m crawl swim with start from water;

8 - 10 m crawl swim with start from water.

Thereby cross experiment confirmed our assumptions expressed after conducting I stage of the pedagogic experiment. Applying the program of qualified water polo players speed abilities development in the middle part of the training session results in significant probable results increase of all the indices.

Discussion

The study of literature, summarizing the experience of sports practice suggests that finding ways of effective physical qualities development of skilled water polo players is an urgent problem of educational and training process.

In theory and practice of sports training, as well as numerous scientific studies, considerable attention was paid to the development of athletes strength capabilities. (Escalante, 2009; Gobbi) Practitioners of various sports could effectively adapt fundamental theoretical position of strength development to specifics of their kinds of sports. However, there was a situation in water polo when in practice of athletes strength training some means are used that don't consider specific motor actions of players and possess all-round developmental character without features of various types of strength capabilities (maximum, explosive, speed strength and strength endurance).

It is known that strength training in modern sport is the basis for improving speed qualities, flexibility and coordination skills, etc. (Escalante, 2012). This encouraged us to search and test the effectiveness of specific strength exercises that increasingly reflect motor activity features in water polo. We can state the general opinion of experts (Lozovina; Luno) concerning the role and importance of different strength qualities for highly competitive activity of water polo players. However, in most studies (Melchiori; Mujika) there is only a

statement of the facts of significant influence of strength capabilities on the efficiency of important gaming techniques and actions of water polo players, and any specific instructions that reveal the peculiarities of either strength exercise and opportunities for efficiency of individual actions and during the game as a whole.

The success of gaming action and special techniques depends largely on the capacities of water polo players while playing the most explosive speed strength and strength endurance. These types of strength significantly affect the performance of players and competitive activity in general. Explosive and maximum strength to some extent determine the speed capabilities, the ability of athletes to show maximum acceleration of efforts. This is particularly important when performing special moves such games as: jumping in the water, ball throws, coups, deceptive movements etc.. Maximum strength plays a major role in the combat with rival. A strength endurance manifests in capabilities of water polo players to maintain optimum strength characteristics of stroke and pushing movements during different relocations, save strength as long as possible while shooting on goal. As it was said above specialists attempts to identify levels of development of these qualities in water polo players can ensure a possibility of reasonable correction of individual training and training process in general.

The studies show that different strength capabilities ambiguous influence on the effectiveness of important motor actions of water polo players and game in general. For example, the rate of maximum traction in the water for 45 seconds, has a high correlation with indicators of acceleration of the ball fly at throw on the ground (r=0,70) and strength of ball throw on the ground (r=0,73).

In the group of parameters that characterize the manifestation of specific strength capabilities in throwing motion on the ground, the following correlation was revealed. There was close connection between the rate of throw range of on the ground and the acceleration of the ball fly at throw on the ground (r = 0.86) as well as strength of the ball throw on the ground (r = 0.70). Also there was close correlation between the range of ball throw on the ground and of the maximum traction on the ground (r = 0.68), maximum traction at the start of the performance in water (r = 0.59).

In recent literature we have found contradictions on the effectiveness of different variants of individual training sessions of speed direction. Experts are offered to use high-speed nature exercises in various parts of the training sessions: at the beginning and in the middle, as well as at the final stage of training (Platonov, 1992; Platonov 2000). It should be stressed that the coverage of these issues in scientific and methodological literature related to water polo hasn't been identified.

Teaching experiment involved the study of strength and speed rate changes of skilled water polo players during the implementation of the original training program, aimed at strength preparedness and use of speed exercises in various parts of training sessions.

While analyzing the results of strength capabilities of water polo players from control and experimental groups it can be indicated that the use of the program in the training process made it possible to improve the strength rates. Almost all strength preparedness rates under study showed that there was higher rate increase in the experimental group compared with the control one.

Pedagogical experiment results showed that the highest training effect of speed qualities of skilled water polo players makes use of high-speed swimming exercises in the middle of the main part of training sessions. Then it goes the use of high-speed swimming exercises at the start of the training sessions. The use of high-speed swimming exercises at the end of the main part of the training sessions show deterioration in speed preparedness rates compared to the use of such exercises in the middle and at the start of an entity.

Thus, the results of the research confirm the fundamental theoretical position of the development of physical capabilities (Chernov, 1974; Reid). Besides, we have confirmed characteristics about the relative effectiveness of speed qualities of athletes at the beginning of the training sessions (Tan), particularly in swimming. At the same time it can't be confirmed that it is reasonable to use speed exercises at the end of training sessions.

At the same time, we have supplemented expediency and necessity of the use of special strength exercises for skilled water polo players. Their structure and content reflect the specific character of motor activity.

Besides, strength training of skilled water polo players should be not overall, but focused. It means that, while planning strength microcycles, the peculiarities of individual athletes' strength capabilities (maximum, explosive, speed strength, strength endurance) during training sessions or certain periods of training must be taken into account.

We have supplemented the information about the structure of training process for skilled water polo players in terms of competitive activities during the annual training cycle.

It can be concluded, that during training sessions of skilled water polo players it is reasonable to apply the developed technique of strength and speed training during the annual training macrocycle.

Conclusions

1. We conducted analysis of scientific-methodic literature and documents regulating training process of qualified water polo players. It showed that the problem of specific purposeful power training of water polo

players using exercises similar by structure to their competitive moves is not finally solved. Theoretic methodical statements on structuring the development of speed qualities in qualified water polo players during training session are almost absent.

2. Obsolete training programs are mostly used for training qualified water polo players teams. While making corrections in the training programs coaches use only general training speed and power exercise not reflecting the specifics of water polo competitions and are unable to provide the expected result.

3. Qualified water polo players' team power training methods need correction that means discrete seizure of exercises aimed only at development of power qualities on land and replacing them by exercises closer to competitive activity water polo players moves in water and special simulators first of all.

4. Experimental program of qualified water polo players' power training included purposeful development of power abilities (maximum, speed, burst power, power endurance). Specific exercises matched water polo players' competitive activity specifics and were effective in previous and main experiment. Using power exercises close to competitive actions of qualified water polo players by structure and content favored significant increase of power abilities of the experimental group's athletes. Growth rates of power indices in experimental group's athletes made from 4,1% to 9,3% and control group – from 0,9% to 2,6% ($p<0,05$).

5. Experimental program of qualified water polo players' speed training included appropriateness test of structuring the application of speed exercises within training session (on the beginning, in the middle part and at the end of main session's part). This program was also efficient in previous and in the main experiment.

Applying speed swimming exercises in the second third of main part of the training session is the most efficient for qualified water polo players speed qualities development.

Using speed swimming exercises in the first third of main part of the training session is comparatively less efficient and favors probable ($p<0,05$) increase of speed indices – 0,87%-4,1%.

Application of speed swimming exercises in second third of the main part of the training session is inefficient and causes probable ($p<0,05$) worsening of speed indices.

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