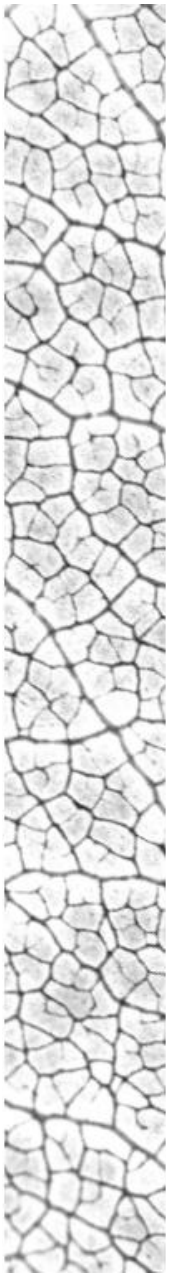

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Improvement of competitive performance in handball through targeted development of significant physical qualities

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Abstract
The relevance of the presented topic is due to the need to study the impact of significant in handball physical qualities on the effectiveness of competitive activities. The main technical actions of handball players are throws from different distances, as well as from different positions. These actions require from the athlete a sufficient level of special strength qualities, and in particular, speed-force. Thus, the strength of the arm muscles and shoulder belt of handball players and handball players is an important quality that largely determines the speed of throwing movements, in this regard, a specific difficulty is precisely to combine at a sufficiently high level of manifestation of power and speed motor capabilities. The research has developed and experimentally proved the method of speed-force training of handball players of the advanced sports specialization stage. The positive influence of significant physical qualities of sportsmen on the efficiency of competitive activity was revealed. The purpose of the study was to provide a theoretical justification and experimental confirmation of the effectiveness of the method of speed-force training for professional handball players. As a result of the research the positive influence of significant physical qualities of sportsmen on the effectiveness of competitive activity was revealed. The work presents the method of high-speed force training of handball players. This technique can be used by handball coaches to improve the effectiveness of special handball training. Also, this method will be useful for coaches of high-speed and power sports, such as javelin or core throwing, as well as in fitness training, as a means of CrossFit.

Keywords: handball, competitive activities, significant physical qualities, speed-force capabilities

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INTRODUCTION

Handball is a sport where speed and force, both explosive and fast, are clearly visible. The special strength of a handball player finds expression in the speed of throwing on goal, from short and long distances, both in jumping and from the supporting position, when passing the ball over a long distance (Bushuyeva, 2013; Vorobyov et al., 2019; Pavlov, Khasanov & Gareeva, 2018; Burelomova, Gulina & Tikhomandritskaya, 2018). Throws on goal are based on handball and are made mainly with maximum effort. Thus, the strength of the arm and shoulder muscles of handball players and handball players is an important quality that largely determines the speed of throwing movements (Kholodov & Kuznetsov, 2017).

In modern methodological literature, the process of educating the muscle strength of handball players has been revealed quite widely, but the available research results have been carried out on athletes-masters or students in the Children's and Youth Sports School of Olympic Reserve of different age groups, often of a contradictory nature (Vorobyov et al., 2018; Kozina, 2016; Kochneva, Grishina & Volozhanin, 2019; Bayanova & Minyaev, 2019).

Speed-force capabilities, as their very name suggests, are a kind of combination of power and speed capabilities. They are based on the functional properties of muscular and other systems, which make it possible to perform actions in which, along with significant mechanical strength, significant speed is required (Stafeeva, Ivanova & Krasnova, 2020; Bystritskaya et al., 2019).

Practically, when performing high-speed-force actions, a specific difficulty is precisely to combine the

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manifestation of power and high-speed propulsion capabilities at a sufficiently high level. At the same time, the greater the external encumbrance, the more the action acquires a power character; the less encumbrance, the greater the action becomes speedy.

It is not unimportant to determine the level of development of speed and power capabilities at all stages of sports training to obtain objective information about the effectiveness of the training process and, if necessary, timely correction.

At present, the most comprehensive study has been conducted of the means and methods of training speed-force capabilities regardless of the sports specialization and qualification of athletes. As for the issues of methods for developing various manifestations of muscle strength in athletes as applied to a particular sport, they have been developed in more detail only in weightlifting and individual types of athletic throwing and jumping (Prieshkina, 2015).

Thus, it is relevant to study methods and technologies for the development of speed-force capabilities in young men playing handball in an institution of additional education.

METHODOLOGICAL FRAMEWORK

The methodological basis of the study was formed by systematic and complex approaches to the study of scientific and practical problems, pedagogical processes, and personal and active approaches to professional training of athletes.

Theoretical basis of the study are fundamental works on general theory of sports and handball.

Despite the fact that the scientific foundations of the theory and methods of sports training were formulated in the works of such leading scientists as D. Harre (1962) and others, they still require systematic development, addition of new knowledge related to specific sports, the level of sportsmanship, as well as various aspects of athletes' preparedness (technical-tactical, physical, psychological).

According to Y.V. Verkhoshansky (1988), further improvement of the high level of achievements of modern sportsmen requires a radical improvement of the entire system of their preparation.

Modern handball is an athletic sports game requiring high physical fitness of those involved (Thorev, 2012).

A wide arsenal of motor skills is extremely important in handball, allowing new motor tasks to be solved, which is essential both in forwards and defensive actions of players (Thorev et al., 2013).

One of the main technical elements in handball is throwing the ball, which is used in passes in the interaction between players and defeating the opponent's goal.

The throw action takes place in high-speed-force mode, the indicators of which can characterize the special preparedness of handball players and have a positive impact on technical skill. There are two areas in which speed-force capabilities are developed: one is related to their improvement in overcoming mode of operation, and the other - in inferior mode.

In the overcoming form, the problem with speed-force training is to find the optimal balance of strength and speed in relation to competitive motor action. The problem with this search is complicated by the fact that speed and overcoming weight are inversely proportional.

Exercises characterized by high power of muscle contraction are used as the main means of training speed and strength. In other words, it is typical for them to have a balance of strength and speed characteristics of movement, in which significant strength is manifested in as little time as possible. This type of exercise is commonly referred to as 'speed-force' exercises. These exercises differ from force exercises with increased speed and therefore the use of less significant burdens. There are many exercises that can be performed without external burdens.

The composition of speed-force exercises in physical education programs is broad and varied. It includes various types of jumps (track and field, acrobatic, supporting gymnastics, etc.), throwing, pushing, throwing and rapid lifting of sports equipment or other items, rapid movements of cyclic nature, a number of actions in games and martial arts performed in a short time with high intensity (in particular, jumps and accelerations in games, boxing drums, partner throws in wrestling), etc. From this extensive set of exercises, those that are more easily adjustable in terms of speed and degree of difficulty are used for strictly regulated influence on speed and strength abilities. Most of these exercises are used with normalized external weights, with periodic variations in the degree of weights, because repeated movements with standard weights, even if performed at the highest possible speed, gradually (often in a relatively short period of time) lead to stabilization of muscle tension levels, which limits the development of speed and strength capabilities.

To avoid such stabilization, additional burdens are also applied and vary in those speed activities that are performed under normal conditions without external burdens or with standard burdens. For example, dosed balance belts and waistcoats or weighted shoes are used for jumping and running acceleration, weighted cuffs in hand-to-hand play, weighted gloves for boxing blows, and projectiles of different weights in athletic throwing.

A special group consists of special exercises with instant overcoming of the impact weighting, which are aimed at increasing the power of effort associated with the most complete mobilization of muscle reactive properties.

Characteristically, they create conditions in the first phase of the action to use the kinetic energy of freely moving weight (by jumping down from some elevation or free lowering of the load on a cable); in the second, shock-absorbing phase, this energy is kind of transmitted to the muscles (at the moment of landing when the load is jumped or at the moment of jerky braking of the free-fall load), causing their inferior, forced stretching, and in the third phase it stimulates the subsequent powerful contraction (by jumping up or jerky crossing the load on a block).

If this type of exercise is performed without delay in the shock-absorption phase and in accordance with developed load-ratio rules, it allows the greatest "explosive" force to be produced. For the sake of brevity, they can be tentatively referred to as "shock-action exercises".

The central methodological problem in training speed and force abilities is the problem of the optimal combination of speed and force characteristics of movements. The difficulties in solving this problem stem from the fact that the speed of movements and the degree of weight loss to be overcome are inversely related. The resulting contradictions between speed and strength characteristics of movements are eliminated by balancing them in such a way that the highest possible power of externally visible force is achieved with the priority of speed of action.

From biomechanics, it is known that the greatest mechanical power in muscle contractions in general is achieved when the speed of contraction and the amount of burden to be overcome is approximately 1/3 of the limit. However, many motor actions need to be performed at higher speeds and with different burdens to be used effectively in physical education and in life. In the process of building up speed and strength, preference is given to exercises that are carried out at the highest speed possible under the conditions of a given weighting and in which it is possible to maintain the correct movement technique (so-called controlled speed); external weighting is limited to within the limits which in most cases do not exceed 30-40 % of the individual maximum. There are exceptions in cases where greater burdens have to be overcome in the target activities, such as in the case of specialization in weightlifting.

"A particularly strict rationing of external weights is necessary when they are used to reinforce the requirements for speed and force in high-speed activities, which in natural conditions are performed with little or no external weights (throwing a ball, other light objects, jumping, etc.). Additional burdens are strictly limited here - so that they do not distort structures and do not degrade the quality of actions.

The effectiveness of speed-force exercises is to some extent proportional to the frequency with which they are included in weekly and longer exercise cycles, provided, however, that during the replay process they can be maintained at a minimum and, better yet, that the speed of movement achieved is increased (with a given weighting). On this basis, the total volume of speed-force exercises is normalized, the number of repetitions in a separate lesson. The dynamics of movement speed also serves as one of the main criteria in regulating rest intervals between repetitions: as soon as movements begin to slow down, it is advisable to increase the rest interval if this helps to restore the necessary speed or to stop repetitions.

Thus, the main methodological requirements in developing speed-force capabilities in overcoming the repetitive behavior are as follows:

The burdens applied in training must be unbounded and each repetition must be carried out at the highest possible speed under these conditions. At the same time, the amount of weighting may be increased to such a level that, firstly, the speed of the exercise does not slowdown in relation to the speed of the competition exercise and, secondly, the technique of the exercise is not significantly compromised.

The amount of weighting applied depends crucially on the proportion of strength and speed components typical of competitive activity. As the share of power capabilities increases, the range of increased burdens increases. Conversely, the higher the speed of competitive activities, the lower the amount of burdens applied.

To increase the speed and strength ability, it is possible to use methods of separate development of only strength or speed. In this case, the best effect is achieved by developing these qualities in parallel rather than in series. In the case of speed-force training, it is not advisable to exercise in a state of fatigue, because it slows down the movements performed. The total amount of speed-force load in a single workout therefore remains insignificant.

RESULTS AND DISCUSSIONS

To substantiate the effectiveness of the experimental method, a number of pedagogical experiments have been conducted.

As a result of the pedagogical stating experiment, handball players' speed-force training indicators were obtained and analyzed, and methodological features of using speed-force training in the training process of sportsmen of this age category were identified.

For example, one of the most important complex speed-force characteristics of handball players is jumping, which is primarily caused by the explosive power of the legs. To develop it, training practice increasingly uses exercises in dynamic high-speed modes: special jumping exercises, pushing and throwing heavy objects, exercises with burdens, etc., performed with maximum intensity.

Based on the above methodological features, a methodology was developed for the development of speed-force capabilities for handball players of the advanced specialization stage.

Young men aged 15-17 participated in the formative pedagogical experiment, with 20 people involved in handball in the institution of additional education. The control and experimental group consisted of 12 and 13 young men, respectively. The aim of the experiment was to justify the effectiveness of the method of developing speed-force capabilities in young men playing handball at the institution of additional education.

The method of young men in the experimental group was based on a sports training program in handball based on the targeted development of significant physical qualities (jumping) and the improvement of speed-force training in various modes of operation (Ignatyeva et al., 2016; Stafeeva, Kuryatnikov & Zhemchug, 2019; Burina & Kudinova, 2020).

In the process of developing the technique, we have identified the main methodological features of using the means and methods of high-speed force training of handball players, according to scientific and methodological literature (Fedorov, 2014; Harre, 1962; Grigorieva et al., 2020; Huu & Zhiyar, 2019).

The following methods were used in the training process for the development of speed-force capabilities of the experimental group (Khomutov & Latyshkevich, 1978):

1.Repeated method. In the application of the repeated method, the training effect on the organism is provided in the period of fatigue after each repetition. This method makes it possible to accurately dose the load, strengthen the musculoskeletal system and influence the cardiovascular and respiratory systems. With this method, the level of jumping is increased by 19-30 %.

2.Interval method. This method is externally like the repeat method. But if, with the repeated method, the nature of the impact of the load is determined solely by the exercise itself, then with the interval method, the rest intervals also have a greater impact on the exercise.

3. Playful method of leapfrogging education. However, this method has a significant disadvantage - the dosage of the load is limited. That is, it turns out that the athlete applies this quality more than he or she is being educated. Of course, there is a certain amount of load and a player gets it if he actively fights under the shield, jumping vertically upwards for the ball that bounced after the opponent's throw on the ring.

It is well-known that the strength and height of a jump depends largely on the strength and power of the calf muscle, ankle, and knee joints. In developing jumping, you should first strengthen the ankle joint and make it strong, elastic, and able to withstand injuries. To this end, V.I. Zhukov recommends that the Achilles tendon and ankle joints be strengthened every morning for at least 5 minutes. Simple but effective exercises are recommended.

For this purpose, handball used exercises to strengthen the muscles of the foot with a shock absorber, with a burden or overcoming the resistance of a partner. Medical balls were used - riding with their feet. Walking and jumping on socks with a burden in hand or on the shoulder. Effective for strengthening the feet and shins of jumping in the sand, with a jump rope, jumping over the barrier on socks, on one or two legs.

Twist movements (legs together) and knee rotation 30-40 times in both directions were used for the knee joint. In addition - bending the legs in the knee joint with a burden, jumping out with a burden, walking on half-bent legs with a bar - in a seat, in a semi seat with turns at each step. Having strengthened the ankle and knee joints, we have already moved on to increasing the intensity of jumping exercises (Tsiganok, 2000).

According to modern handball experts, the method of jumping training has changed due to the acceleration of all stages of the game. Jumping from a low handball rack is not successful: straightening, bending legs in the knee joint takes precious time, and often the ball is taken by the opponent with a more "loaded" (ready to push) foot and less bent knee joints.

We present an example of the content of a pre-competition microcycle for handball players at the advanced specialization stage. On the first day of each microcycle, a combination of strength and coordination load is preferable.

The aim of the second day is to improve the speed and explosive power of the hands using stuffed balls. On the 2-day microcycle, instead of speed exercises, tasks can be programmed to develop special endurance or jumping skills.

The main task of the third day of the 3-, 4- and 6-day microcycles is to develop special endurance. The third and fourth days can be combined with jumping. The last days of the general and special training microcycles should be focused on improving or maintaining the necessary level of overall endurance of athletes (**Table 1**).

A training day combines 2-3 sessions. The crushing of the training load for one day is necessary due to the variety of tasks to be solved. It is important to determine the optimum duration of training sessions and the alternation of loads of different preferential orientations.

Currently, 2 training sessions are most often held per day. Three-day training sessions during the day are mainly used in the general training phase and in the educational process.

V.I. Thorev (2012) offers a rational distribution of training sessions within one day. In the conditions of the educational and training process, handball players must receive the highest load during the evening sessions. In morning training, it is necessary to limit difficult

Table 1. Content of the pre-competition micro cycle of the handball training process of the advanced specialization stage

Load direction	Duration of microcycle, day								
	2		3			4			
	Microcycle days								
	1-st	2-nd	1-st	2-nd	3-rd	1-st	2-nd	3-rd	4-th
Powerfulness	xx	x	xx	x	-	xx	x	-	-
Speed ability	x	xx	x	xx	-	x	xx	-	-
Special endurance	-	xx	-	x	xx	-	-	xx	x
Coordination ability	xx	x	xx	x	x	xx	x	x	x
Speed-force ability	x	xx	x	xx	x	x	xx	x	x
Jumping ability	-	xx	-	x	xx	-	x	xx	x

Table 2. Rapid-force training indices of handball players of the control and experimental group at the end of the experiment

Indicator	Control group n=10	Experimental group n=10	Reliability of differences p ≤ 0,05
Throw the stuffed ball (1 kg) with two hands from behind the head, from the sitting position (m).	8,7 ±0,21	10,2±0,6	t=2,65 p<0,05
Triple jump from the place (cm).	752,2 ±2,4	768,9±2,31	t=2,47 p<0,05
Jump up (cm).	44,6 ±0,09	53,5±0,5	t= 2,54 p<0,05
Lifting the torso from lying position with bent knees (number of times).	27,0±0,2	33,4±0,7	t=2,56 p<0,05

coordination exercises and energy-intensive means of influence.

At the general training stage, it is preferable to conduct technical-tactical training with a low level of load during the morning hours; during the daytime - physical training with an average level of training impact; in the evening hours - complex or technical-tactical training with a high level of load.

In the case of two one-time exercises, the construction of daytime training at this stage implies a technical-tactical oriented training with an average level of load in the morning and a complex or high level of training impact in the afternoon.

Thus, one of the most important complex speed-force characteristics of handball players is jumping, which is primarily caused by the explosive power of the legs. In order to develop it, training practice increasingly uses exercises in dynamic high-speed modes: special jumping exercises, pushing and throwing heavy objects, exercises with burdens, etc., performed with maximum intensity.

As a result of the introduction of the speed-force training method into the training process of handball players within six months, we have identified reliable differences in the studied indicators between control and experimental group athletes.

The results of the testing of boys in the pedagogical shaping experiment revealed reliable differences in speed-force training among boys in the control and experimental groups involved in handball in Children's and Youth Sports Schools (**Table 2**).

As a result, we have found reliable differences in the studied indicators of speed and force readiness of young men in the tests "Throw of a stuffed ball (1 kg) with two hands from behind the head, from sitting position", "Triple jump from a seat", "Jump up", "Raising the torso from lying position with bent knees" between control and experimental handball groups.

The result in the triple jump of the experimental group was 768.9±2.31 cm long, the control group 752.2±2.4 cm long, the differences are reliable ($p<0.05$).

In the test, the upward jump in the boys of the control group was 44.6 ±0.09 cm, and in the experimental group it was 53.5 ±0.5 cm ($p<0.05$). In the test of torso elevation from a lying position with bent knees in the control group boys the indicator was 27.0±0.2 times, in the experimental group - 33.4±0.7 times, the differences are reliable.

The result in the test of throwing a stuffed ball (1 kg) with two hands from behind the head, from sitting position at the boys of the control group was 8.7 ±0.21 m, in the experimental group - 10.2 ±0.6 m, the differences are reliable ($p<0.05$).

We also conducted and analyzed results in special tests of field players and goalkeepers in the control and experimental groups. The results at the end of the experiment in a comprehensive exercise for the field player and goalkeeper are shown in **Fig. 1**.

In a special test for field handball players, the results in the control group for boys at the end of the experiment were - 20.5 ±0.01 s, in the experimental group - 18.9 s, the differences are reliable ($p<0.05$). In the test for goalkeepers in the control group of young men the speed-force ability index was 31.5±1.2 times, in the experimental group - 42.7±0.09 times, the differences are reliable ($p<0.05$) (**Fig. 1**).

Thus, the results obtained allow us to conclude that as a result of a pedagogical shaping experiment, the effectiveness of the method of developing speed-force capabilities of young men involved in handball at an additional education institution has been identified, which has had an impact on the increase in speed-force capabilities.

A comparison of the speed-force training indicators obtained with the data on special physical training presented in the Children's and Youth Sports School program shows that the results in the tests meet the

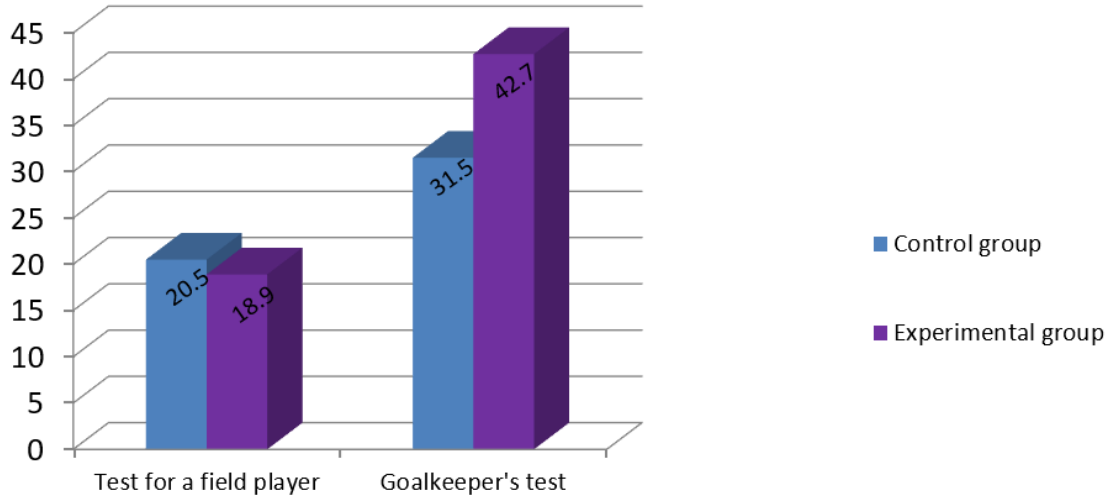

Fig. 1. Dynamics of special tests for field players and goalkeepers of the control and experimental group during the experiment

standards for advanced specialization groups and in some tests exceed them.

The use of dynamic exercises in different modes and methods in the training process of handball players allows them to effectively improve both the level of fast force and explosive strength, which in turn ensures high performance in competitive activities.

CONCLUSION

Based on an analysis of the scientific and methodological literature, it has been determined that the specific features of jumping are explosive power, speed, and rhythm of movements. The amount of effort developed in the shortest possible time when jumping should be extremely large. This is only possible with their explosive nature. The relationship between speed and force is manifested in the power of the movements. A short and strong repulsion requires instantaneous muscle contraction at a high level of tension, which requires a strong concentration of volitional effort. Handball players use exercises in dynamic speed modes to develop their jumping ability: special jumping exercises, pushing and throwing heavy objects, exercises with burdens, etc., which are performed with maximum intensity.

In the course of the study, tests were selected to assess the speed-force abilities of young handball players, such as: throwing a stuffed ball (1 kg) with two hands from behind the head, from sitting position, triple jump from sitting position, jumping up, raising the body from lying position with bent knees. Also, special tests to assess the field player and goalkeeper. In this comprehensive exercise, speed and strength qualities are manifested in specific competitive movements, in various combinations and against the background of fatigue. This makes this test as close to the competition as possible and increases its informative value.

RECOMMENDATIONS

The following methodological guidelines must be followed when organizing a training process with handball players in the advanced specialization stage:

1. When planning the special physical training of handball players, it must be considered that the greatest correlation with the effectiveness of competitive activities in handball has to do with speed-force capabilities.

2. When performing special loads, it is necessary to observe strict rationing of external weights, when they are used to reinforce the requirements for speed-force capabilities in high-speed activities, which in natural conditions are performed with little or no external weights (throwing a ball, other light objects, jumping etc.). Additional burdens must be strictly limited - so that they do not distort structures and do not impair the quality of actions.

3. An empirical rule on the use of speed-force exercises must be observed when planning speed-force loads: “it is “better” to exercise more often (in terms of the frequency of exercises in weekly and other cycles), but little by little” (in terms of limiting the amount of load in a single exercise). This is explained by the fact that the short duration of the speed-force exercises and the limited amount of load applied to them allow them to be performed in each session as a series and in several series. At the same time, the maximum concentration of will, the full mobilization of speed-force capabilities and the need to prevent any deterioration in speed characteristics of movements each time they are repeated significantly limit the volume of load.

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