

## Features of sports training of archers based on the use of simulators

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Published online: October 31, 2022

(Accepted for publication October 15, 2022)

DOI:10.7752/jpes.2022.10322

### Abstract:

A qualitative increase in the technical skill of archers requires the use of effective training simulators during sports training. **The purpose** of the study was to develop and experimentally justify the use of technical devices to increase physical and technical preparation levels of archers. **Material and methods.** Twenty-six young archers (age 12–13 years old) who participate in archery at City Specialized Children and Youth Sports School of Olympic Archery Reserve "Komunar" in Kharkiv participated in the study. Control and experimental groups of 13 people per group were randomly selected. All participants agreed to participate in the experiment. The study was carried out from January to November 2021. At the beginning of the experiment and at the end of the study, all participants passed physical and technical fitness testing. Testing of athletes in terms of physical readiness (30 m sprint, shuttle run 4x9 meter, forward bend while sitting, long jump from a place, push-ups within 30 seconds, and Romberg's test), technical readiness (holding the bow in the "stretch", stretching the bow within 30 s, archery 18 m, archery 60 m) and methods of mathematical statistics were applied. **Results.** The technical devices "Posture Practice", "Elbow Pad", and "Balancing Board" used for the development of physical qualities and technical techniques were previously developed and implemented in the training process of archers. The description and technical characteristics of these training simulators are provided, and the methodology of their application in terms of practical activity of archers was previously described. **Conclusions.** As a result of the experiment, significant differences were found between the control and experimental groups according to the results of the tests "Shuttle run 4x9 m", "Stretching the bow by hand in 30 s", "Archery 18 m", and "Archery 60 m" ( $p < 0.05$ ;  $p < 0.01$ ) in the experimental group. These indicators were significantly higher in comparison with athletes in the control group. The introduction of training simulators influenced the improvement of the archery technique. The athletes in the experimental group managed to develop a biomechanically appropriate movement structure due to which the indicators of competitive activity increased.

**Key words:** archery, simulator, technical readiness, physical fitness.

### Introduction

Ukrainian archery has a glorious history: three Olympic medals and a large number of awards at the European and World Championships, World and European Cups. Today, Ukrainian archers represent Ukraine at international competitions (adult and junior), winning prizes. As experts emphasize, each award is the result of the fruitful joint work of an athlete and a coach. Therefore, no athlete will succeed without coaching experience and a properly constructed training system (Artiuh et al., 2019). Qualitative improvement of sports and technical skills is the main task during the training of archers.

Modern archery is a complex and technical sport that makes great demands on the physical, technical, tactical and psychological training of athletes of various qualifications. At the same time, it is an interesting and affordable sport for beginner archers due to its emotional appeal and low energy consumption. The practice of sports work and the results of scientific research show that systematic training for 8-10 years is necessary to achieve international class results in shooting sports. In this regard, at each stage of long-term training, it is necessary to search for the most effective ratios of loads of different orientations and new forms of organization of the training process (Briskin, Pityn, Antonov, Vaulin, 2014).

Theoretical analysis of scientific and methodological research in archery indicates the existing scientific data on increasing the effectiveness of training with the help of control exercises with complicated performance conditions (shooting sitting on a chair, standing on a platform with closed eyes), using a balance board with an additional optical sight and special target exercises, as well as due to the improvement of technical means of learning by motor actions (Gonzalez et al., 2017; Tarasova, Korzhenevsky, Tarasov, Mamichkin, 2021).

Scientists Pitin, Stetskovich, Khitrov (2017) highlighted the importance of the components of the theoretical training of archers at the early stages of long-term training using the method of expert evaluation.

An interesting study was conducted by the scientist Pyatkov et al (2016), who examined the system of express diagnostics of the visual-motor function of a person. Through the method of computer registration and analysis of time parameters, I found statistically significant data. The work supplemented knowledge about the effect of physical exercises on the work of the athlete's visual-motor apparatus.

Skripka, Lapitsky, Goncharenko, Solonenko (2019) devoted their research to the specifics of the physical training of athletes in the structure of sports improvement in archery. In the article "Peculiarities of sports training of students-archers in groups for improving sports skills" they noted that "the rational use of special archery exercises available to students can significantly improve their sports training and thereby improve their sports qualifications".

Modern scientific research is devoted to the issues of the content of sports training of representatives of archery, focused mainly on the training of qualified athletes (Musa, Majeed, Taha, Chang, Nasir, Abdullah, 2019; Dorshorst et al., 2020). Scientists have established that the sports success of highly qualified shooters and archers is largely determined by the athlete's coordination abilities. The stability of the "archer-bow" system largely depends on the ability to manage this system under the influence of external and internal environmental factors: the speed of the shot, the content of the front sight during aiming, the processing of the shot (Zhang, Zhou, Luo, 2020). Scientists note the importance of the problem of the archer's psycho-emotional stability, which is essentially expressed in the length of time the front sight remains in the center of the target until it comes to a complete stop. The authors of Sobko, Kovtun, Ulaeva (2019), Sobko, Zharkova, Vitsko, Zhukov, Tsapko (2020) determined the factor structure of the functional state and special physical performance of skilled archers, which made it possible to identify the most significant factors. In connection with taking into account the specifics of the competitive activity of archers and their specialization, the importance of physical and technical preparation in the formation and improvement of sportsmanship of athletes increases (Lau, Ghafar, Hashim, Zulkifli, 2020).

In the modern sports training of archers, various technical means are widely used to intensify the development of motor qualities and improve the characteristics of the technique of sports exercises. At the same time, there is an urgent need to develop new tools, methods and technologies that will allow the coach to improve the organization of the athlete's training. As experts note, for the training of shooters, it is necessary to skillfully and rationally plan the training process and correctly apply various technical means according to the level of sportsmanship of the archers (Tarigan et al. 2017). Modern training methods of athletes require individualized training process depending on readiness of an athlete and must be adjusted to achieve the maximum result (Taha, Musa, Majeed, Abdullah, Zakaria, Alim 2017). It can be achieved not only with the help of commonly used technologies, but also widely using simulators. When mastering complex models of technique in the training of archery athletes, it is advisable to use specialized training systems that make it possible to simulate quite reliably the conditions of the environment in which the athlete will realize his strength potential. Such simulators make it possible to "significantly intensify the process of improving the athlete's technical skill" [5]. They are applied taking into account motor (biomechanical) specifics, and loads are provided taking into account the individual characteristics of athletes. Technical means in sports are devices, systems, complexes and equipment used for training effects on various parts and systems of the body, for learning and improving motor skills, as well as for obtaining information in the process of training and training sessions with the aim of increasing their effectiveness [18]. Training devices can be used to develop both the general physical qualities of archers, and to master and improve individual elements of the technique of shooting with classical and block bows. However, the characteristics of the features of their use in working with sportsmen-archers are not sufficiently covered in methodical revisions. Therefore, the study of the use of simulators in the educational and training process of archers is an important and relevant direction.

*Thus, the purpose of this study* is the development and experimental justification of the use of technical simulators to increase the level of physical and technical fitness of young athletes who specialize in classical archery.

### **Material & methods**

Participants: 26 young archers (age 12-13 years old) participating in the study are engaged in classical archery at the City Specialized Children and Youth Sports School of Olympic Archery Reserve "Komunar" in Kharkiv. Control and experimental groups of 13 people were randomly selected. All participants agreed to participate in the experiment.

**Procedure** The study was conducted from January to November 2021. At the beginning of the experiment (January-April 2021), all research participants passed physical and technical fitness testing.

*To determine the level of development of physical readiness of athletes, the following tests and attributes were used:*

Jumps with skipping rope (number of times). Jumps with pulling the knees to the chest (number of times). Push-ups 30 s (number of times). Standing long jump (cm). Shuttle run 4 x 9 meters was performed with a stop and touching the line. The execution time was fixed (s). 30 m sprint (s). Long jump from a place (cm). Forward bend while sitting, (number of times). Romberg's test (s).

*To determine the level of technical development of athletes, the following tests were used:*

Holding the bow in the "stretch". Testing was performed while standing, and the execution time (s) was recorded. Stretching the bow within 30 seconds. Testing was performed standing, the number of times was recorded. Archery 18 m (number of points). Shooting is carried out indoors at the distance of 18 meters at the target (120 seconds per series). A total of 20 series of 3 arrows are given. The number of points scored is fixed. Archery 60 m (number of points). Shooting is carried out in the open air at a distance of 60 meters at the target (240 s per series). A total of 12 series of 6 arrows are given. The number of points scored is fixed.

Before the experiment, the competitive exercise "Archery 18 m indoors" was held at the All-Ukrainian competition "Ruban's Cup", which was held in the city of Kharkiv on January 14-17, 2021. The competitive exercise "Archery 60 m in the open air" was held at the open All-Ukrainian competitions "Olympic Hopes", which took place in the city of Lviv on April 19-23, 2021. At the end of the experiment (November 2021), all research participants also passed physical and technical fitness testing. Indicators of the competitive exercises "Archery 18 m indoors" (held at the All-Ukrainian competition "Kyiv lights" in Kyiv, October 29-31, 2021) and "Archery 60 m in the open air" (held at the open All-Ukrainian competition "Golden Autumn", which took place in Lviv on September 6-11, 2021) were analyzed at the end of the experiment. The control group was trained according to the generally accepted program of the City Specialized Children and Youth Sports School of Olympic Archery Reserve "Komunar" in Kharkiv. During the experiment, the technique of using the technical simulators "Posture Practice", "Elbow Pad", "Balancing Board" for the development of physical qualities of archers was introduced into the educational and training process of the young athletes of the experimental group.

During training classes of archers, the simulator "Posture Practice" is effective (Fig. 1). This simulator is designed for physical and technical training, it can be described as mechanical, individual, linear. It belongs to strength simulators: a system of blocks is used, but it has a multifunctional value: it develops strength abilities, trains muscle memory, increases the archer's strength endurance. The simulator consists of an iron vertical rack (height 1 m 50 cm) with a metal cross-shaped base, which ensures the static structure; two blocks fixed perpendicularly to the rack (the first at the height of 1m 20 cm, at a distance of 20 cm from the rack, the second one at the height of 1m 40 cm directly on the rack), a metal cable passing through both blocks and weights (500 g, 2500 g, 3000 g, 4000 g).



Fig. 1. Illustration of the simulator "Posture Practice".

This simulator involves the use of the method of repeated efforts, the essence of which is that in the process of motor activity, the archer makes significant muscle tension, but the limit of effort is determined not by the amount of weight or resistance, but by the number of repetitions.

At the initial number of repetitions (4-8) in one approach, the development of mainly absolute muscle strength occurs. If the number of repetitions is 12 or more with average (40-50%) resistance, strength endurance is mainly developed. For the purpose of moderate development of strength and power endurance, it is possible to recommend an exercise simulating bow tension using the method of repeated efforts.

Before performing the exercise, it should be remembered that all technical actions for bow tension are divided into three phases:

- 1) the angle between the line of the shoulders and the hand performing the tension of the bow (exercise device), 90-100 ° (position when tensioning the bow), the angle in the elbow joint 80-90 °;
- 2) the angle between the line of the shoulders and the hand performing bow tension, 120-130 °, in the elbow joint 50-60 ° (average position);
- 3) the angle between the line of the shoulders and the hand performing bow tension, 160-170 °, in the elbow joint 30-40 ° (final position).

Starting position: the athlete stands facing the simulator, feet shoulder-width apart. The left arm is straightened - rest on the rack parallel to the floor at a right angle to the axis of the body, the right arm is bent at the elbow, the forearm moves parallel to the floor, while pulling the cable, on the other end of which a load is fixed, which rises due to the work of two blocks. The number of repetitions is 8-10, the number of sets is 3-5. Then the athlete changes his hand, performs the same exercise with the other hand. Usually, the exercise on this simulator is done at the end of training with an emphasis on the left arm to ensure an even load on the muscles of the shoulders and trunk. The exercise is performed individually under the control of the coach, who controls the posture and movements of the athlete. The archer can also perform this exercise in front of a mirror. The load, including the weight of the loads, is regulated by the coach in accordance with the athlete's age and physical form. A technical simulator aimed at working out the archer's traction skills is the "Elbow pad" (Fig. 2). This device is individual, mechanical, with a linear program, and its effect on the body is local, because separate muscle groups are involved in the work. The "Elbow pad" also involves the use of the method of repeated efforts.



Fig. 2. Illustration of the technical device "Elbow Pad"

The "elbow pad" consists of two fabric strips fastened at the ends, forming a "basket" for the elbow. A rope is attached to the strips with a hook that catches the bowstring.

Starting position: feet shoulder-width apart, left arm straightened parallel to the floor, holding a bow. The right arm is bent at the elbow, which is fixed in the "basket", to be on the same line as the left arm. The hook hooks onto the bowstring. The archer moves the elbow as far back as possible parallel to the floor, stretching the bow, makes an empty shot, after which the movement of the thrust continues. Then it returns to the original position of the hands. The number of series is 5, 6 shots each. Performing the exercise alternates with archery training without a simulator. The number of approaches is regulated by the coach (no more than three during training). The exercise is performed only on the pulling hand (for a left-handed archer it will be the left hand). The advantage of using this simulator is that it is individual and compact, easy to use, so it can be used both in the shooting range and during outdoor training, even during away training sessions.

One of the more common simulators that ensure the development of coordination abilities of athletes is the "Balance board" (Fig. 3). This simulator is individual in the form of training, mechanical and general, because most of the muscles of the body are involved in working with it. The development of general and special dexterity is carried out by developing a sense of space, time, the ability to maintain the balance of the "archer-bow-target" system. The balance of the archer's body ensures a state of equilibrium. Holding a bow weighing 3-5 kg during three phases of shooting with an outstretched hand (taking into account the force of the wind during outdoor competitions) requires the athlete to have the ability to balance and maintain balance. For this, exercises on balancing boards are used in the training of archers.



Fig. 3. Illustration of the technical simulator "Balance Board"

### Statistical analysis

The digital material obtained during the research was processed using the methods of mathematical statistics using Microsoft Excel, SPSS, 20.0. For each indicator, the arithmetic mean value  $x$ , the mean square deviation  $S$ , the representativeness error  $m$ , the assessment of the probability of discrepancies between the parameters of the initial and final results according to the Student's  $t$ -criterion with the corresponding level of probability ( $p$ ) were determined. The sample was tested for normality of distribution using the one-sample Kolmogorov-Smirnov's test.

## Results

According to the data in Table 1, for all test indicators, in the experimental and control groups,  $p > 0.05$ , this indicates that there is no significant difference between the subjects in the groups from the normal distribution, and therefore it is possible to use statistical data for calculations in these groups.

**Table 1** Results of testing the hypothesis of normality of distribution according to the one-sample Kolmogorov-Smirnov's test of the experimental ( $n = 13$ ) and control ( $n = 13$ ) groups before the experiment

The name of the test	Control group		Experimental group	
	p	Decision	p	Decision
Shuttle run 4x9 m, number of times	0,955	The null hypothesis is accepted	0,884	The null hypothesis is accepted
Push-ups within 30 s, (number of times).	0,778	The null hypothesis is accepted	0,742	The null hypothesis is accepted
Jumps with skipping rope 1min, (number of times).	0,940	The null hypothesis is accepted	0,990	The null hypothesis is accepted
30 m sprint, s	0,967	The null hypothesis is accepted	0,616	The null hypothesis is accepted
Romberg's test, s	0,737	The null hypothesis is accepted	0,947	The null hypothesis is accepted
Long jump from a place, cm	0,537	The null hypothesis is accepted	0,876	The null hypothesis is accepted
Forward bend while sitting within 1 min, (number of times).	0,960	The null hypothesis is accepted	0,656	The null hypothesis is accepted
Holding the bow in the "stretch", s	0,761	The null hypothesis is accepted	0,879	The null hypothesis is accepted
Stretching the bow within 30 s, (number of times).	0,935	The null hypothesis is accepted	0,874	The null hypothesis is accepted
Archery 18 m, (number of points)	0,992	The null hypothesis is accepted	0,991	The null hypothesis is accepted
Archery 60 m, (number of points)	0,955	The null hypothesis is accepted	0,987	The null hypothesis is accepted

The construction of an educational and training process in archery with the use of training simulators had a positive effect on the level of physical and technical preparedness of the archers of the experimental group.

**Table 2** Results of testing the physical and technical readiness of the archers of the experimental ( $n = 13$ ) and control ( $n = 13$ ) groups before conducting the experiment

The name of the test	Group	Statistical indicators				
		$\bar{X}$	S	m	t	p
Shuttle run 4x9 m, (number of times).	C	11,85	0,56	0,15	1,40	0,17
	E	11,53	0,59	0,16		
Push-ups within 30 s, (number of times).	C	26,69	2,63	0,73	0,74	0,47
	E	25,92	2,66	0,74		
Jumps with skipping rope within 1min, (number of times).	C	113,00	5,69	1,58	0,65	0,52
	E	114,54	6,35	1,76		
30 m sprint, s	C	5,58	1,41	0,11	-0,68	0,54
	E	5,48	1,35	0,10		
Romberg's test, s	C	30,33	3,40	0,94	-1,32	0,33
	E	31,00	3,49	0,97		
Long jump from a place, cm	C	199,15	10,97	3,04	0,28	0,78
	E	198,15	6,91	1,92		
Forward bend while sitting within 30 s, (number of times).	C	32,23	2,89	0,80	0,45	0,66
	E	32,77	3,22	0,89		
Holding the bow in the "stretch", s	C	33,85	6,50	1,80	0,64	0,53
	E	32,38	5,11	1,42		
Stretching the bow within 30 s, (number of times).	C	17,15	2,15	0,60	-0,62	0,54
	E	17,77	2,89	0,80		
Archery 18 m, (number of points)	C	466,38	21,28	5,90	0,68	0,50
	E	462,00	29,61	2,67		
Archery 60 m, (number of points)	C	461,31	21,79	6,04	-0,35	0,73
	E	462,85	20,62	5,71		

\*C – control group before the experiment; E – experimental group after the experiment

This change is less pronounced in athletes of the control group. At the beginning of the experiment, the control and experimental groups did not reliably differ from each other in all test indicators ( $p > 0.05$ ) (Table 2).

After the experiment, the archers of the control group showed a significant improvement in the results of the test "Forward bending of the body from a sitting position within 1 minute, number of times" ( $p < 0.01$ ) (Table 3).

**Table 3** Results of testing the physical and technical fitness of archers of the control ( $n = 13$ ) group before and after the experiment

The name of the test	Group	Statistical indicators				
		$\bar{X}$	S	m	t	p
Shuttle run 4x9 m, (number of times).	C <sub>1</sub>	11,85	0,56	0,15	1,38	0,18
	C <sub>2</sub>	11,57	0,46	0,13		
Push-ups within 30 s, (number of times).	C <sub>1</sub>	26,69	2,63	0,73	-0,77	0,45
	C <sub>2</sub>	27,54	2,93	0,81		
Jumps with skipping rope within 1min, (number of times).	C <sub>1</sub>	113,00	5,69	1,58	-3,62	0,29
	C <sub>2</sub>	119,31	2,69	0,75		
30 m sprint, s	C <sub>1</sub>	5,58	1,41	0,11	0,27	0,19
	C <sub>2</sub>	5,33	1,20	0,06		
Romberg's test, s	C <sub>1</sub>	30,33	3,40	0,94	0,98	0,34
	C <sub>2</sub>	34,31	2,78	0,77		
Long jump from a place, cm	C <sub>1</sub>	199,15	10,97	3,04	-0,78	0,44
	C <sub>2</sub>	202,31	9,59	2,66		
Forward bend while sitting within 30 s, (number of times)	C <sub>1</sub>	32,23	2,89	0,80	-2,80	<b>0,01</b>
	C <sub>2</sub>	34,77	1,54	0,43		
Holding the bow in the "stretch", s	C <sub>1</sub>	33,85	6,50	1,80	-0,91	0,37
	C <sub>2</sub>	35,92	5,02	1,39		
Stretching the bow within 30 s, (number of times).	C <sub>1</sub>	17,15	2,15	0,60	-0,60	0,55
	C <sub>2</sub>	17,69	2,39	0,66		
Archery 18 m, (number of points)	C <sub>1</sub>	466,38	21,28	5,90	-0,62	0,54
	C <sub>2</sub>	470,77	13,20	3,94		
Archery 60 m, (number of points)	C <sub>1</sub>	461,31	21,79	6,04	0,64	0,55
	C <sub>2</sub>	466,92	22,38	6,20		

\* C1 – control group before the experiment; C2 – control group after the experiment.

As a result of the experiment in the experimental group, the indicators of 5 tests increased after the experiment: "Romberg's test", "Long jump from a place", "Holding the bow in the "stretch", "Stretching the bow within 30 s", "Archery 18 m" ( $p < 0.05$ ;  $p < 0.01$ ) (Table 4). The increase in indicators of special physical and technical preparedness can be explained by the use of simulators "Practice of posture" and "Elbow Pad", because these simulators are aimed at practicing the pulling skills of the archer, develop strength abilities, train muscle memory, and increase the strength endurance of the archer. The use of "Balance Board" improves coordination abilities of athletes, namely, maintaining balance. Development of coordination is carried out by improving the sense of space and time, the ability to maintain the balance of the " archer-bow-target" system, as well as rationally alternate tension and relaxation of individual muscle groups. The main way to develop coordination is mastering new, diverse motor skills and abilities. After the experiment, reliable differences were found between the control and experimental groups. According to the results of the tests "Shuttle run 4x9 m", "Stretching the bow within 30 s", "Archery 18 m", "Archery 60 m" ( $p < 0.05$ ;  $p < 0.01$ ) in the experimental group, these indicators are significantly higher compared to athletes of the control group; (Table 5). Effective work with young athletes is possible only on the basis of taking into account the physiological changes that occur in the body of teenagers, the age from 12-13 years is the most favorable for the development of special physical qualities and the formation of specific coordination abilities. It is recommended to pay special attention to the development and improvement of the archer's ability – the differentiation of the speed of the "pulling" of the arrow in the bow, as well as the ability of archers to long-term and effective work aimed at repeated bow tension. **Table 4** The results of testing the physical and technical readiness of the archers of the experimental ( $n = 13$ ) group before and after the experiment

The name of the test	Group	Statistical indicators				
		$\bar{X}$	S	m	t	p
Shuttle run 4x9 m, (number of times).	E <sub>1</sub>	11,53	0,59	0,16	1,67	0,11
	E <sub>2</sub>	11,19	0,43	0,12		
Push-ups within 30 s, (number of times).	E <sub>1</sub>	25,92	2,66	0,74	-1,46	0,16
	E <sub>2</sub>	27,15	1,46	0,41		
Jumps with skipping rope within 30 s, (number of times).	E <sub>1</sub>	114,54	6,35	1,76	-1,08	0,29
	E <sub>2</sub>	117,00	5,20	1,44		
30 m sprint, s	E <sub>1</sub>	5,48	1,35	0,10	0,22	0,63
	E <sub>2</sub>	5,35	1,22	0,06		
Romberg's test, s	E <sub>1</sub>	31,00	3,49	0,97	-3,07	<b>0,01</b>
	E <sub>2</sub>	34,54	2,26	0,63		

Long jump from a place, cm	E <sub>1</sub>	198,15	6,91	1,92	-2,94	<b>0,01</b>
	E <sub>2</sub>	205,23	5,26	1,46		
Forward bend while sitting within 30 s, (number of times)	E <sub>1</sub>	32,77	3,22	0,89	-1,01	0,32
	E <sub>2</sub>	33,92	2,56	0,71		
Holding the bow in the "stretch", s	E <sub>1</sub>	32,38	5,11	1,42	-2,70	<b>0,01</b>
	E <sub>2</sub>	36,85	3,05	0,85		
Stretching the bow within 30 s, (number of times).	E <sub>1</sub>	17,77	2,89	0,80	-2,71	<b>0,01</b>
	E <sub>2</sub>	20,85	2,91	0,34		
Archery 18 m, (number of points)	E <sub>1</sub>	462,00	29,61	8,21	2,31	<b>0,03</b>
	E <sub>2</sub>	486,15	23,27	6,45		
Archery 60 m, (number of points)	E <sub>1</sub>	462,85	20,62	5,71	-2,04	0,04
	E <sub>2</sub>	481,77	26,14	7,24		

\*E1 – experimental group before the experiment; E2 – experimental group after the experiment.

**Table 5** The results of testing the physical and technical readiness of the archers of the experimental (n = 13) and control (n = 13) groups after the experiment

The name of the test	Group	Statistical indicators				
		$\bar{X}$	S	m	t	p
Shuttle run 4x9 m, (number of times).	E	11,19	0,43	0,12	-2,15	<b>0,04</b>
	C	11,57	0,46	0,13		
Push-ups within 30 s, (number of times).	E	27,15	1,46	0,41	-0,42	0,67
	C	27,54	2,93	0,81		
Jumps with skipping rope within 1min, (number of times).	E	117,00	5,20	1,44	1,42	0,16
	C	119,31	2,69	0,75		
30 m sprint, s	E	5,35	1,22	0,06	0,04	0,12
	C	5,33	1,20	0,06		
Romberg's test, s	E	34,54	2,26	0,63	-0,23	0,81
	C	34,31	2,78	0,77		
Long jump from a place, cm	E	205,23	5,26	1,46	0,96	0,34
	C	202,31	9,59	2,66		
Forward bend while sitting within 30 s, (number of times)	E	33,92	2,56	0,71	1,02	0,31
	C	34,77	1,54	0,43		
Holding the bow in the "stretch", s	E	36,85	3,05	0,85	0,56	0,51
	C	35,92	5,02	1,39		
Stretching the bow within 30 s, (number of times).	E	20,85	2,91	20,85	3,02	<b>0,01</b>
	C	17,69	2,39	0,66		
Archery 18 m, (number of points)	E	486,15	23,27	6,45	2,07	<b>0,05</b>
	C	470,77	13,20	3,94		
Archery 60 m, (number of points)	E	481,77	26,14	7,24	1,55	0,34
	C	466,92	22,38	6,20		

\*E - experimental group after the experiment; C - control group after the experiment

Thus, the introduction of training simulators influenced the improvement of archery performance. The athletes of the experimental group managed to form a biomechanically appropriate structure of movements, due to which the indicators of competitive activity increased. One of the main indicators of technical skill is the efficiency and economy of actions, while the indicators of high accuracy and reliability, which ensure the stability of the sports result, are considered equally important. After all, archery in competitive conditions requires the athlete to repeatedly use muscle efforts in static, overcoming and translational modes and ensure stretching of the bow (15-20 kg), holding the pose at the moment of aiming (up to 10 s).

## Discussion

The research hypothesized that the use of training simulators in the training process will increase the level of physical and technical fitness of young athletes who specialize in classical archery. This hypothesis was fully confirmed. The obtained results are consistent with the studies of Gulich O.O, Gulich O.G, Gulich I.G, Ganjave, Dabholkar (2021), it is at this age that special attention should be paid to the development of physical and technical training.

Many scientists research the specifics of physical training of athletes in the structure of sports improvement of archers. Experts emphasize that one of the important qualities for achieving a better result of an athlete is dexterity, which consists in "the ability to quickly master coordination actions, as well as quickly adjust motor activity in accordance with a change in the situation" (Iedynek et al., 2017; Park, 2019; Hidayat et al. 2021; Kanishchev et al. 2021). A high level of coordination abilities allows you to quickly master new motor skills; rationally use the existing stock of abilities, skills and motor qualities – strength, speed, flexibility; to reveal the necessary variability of movements in accordance with specific situations of training and competitive activities. As a result of the use of various types of "Balance Boards" in the athletes of the experimental group, a

significant ( $p < 0.01$ ) improvement in the indicators of coordination ability testing was found in comparison with the control group. This can be explained by the fact that coordination capabilities are manifested in the appropriate choice of motor actions from the arsenal of mastered skills. Therefore, it is natural that coordination abilities depend on the motor readiness of the archer, the number and complexity of mastered skills, as well as on the effectiveness of mental processes that determine the reliability of movement control and ensure the simultaneous performance by the archer of the technical actions necessary for the execution of the shot, ensuring stability and adequate response to changing the conditions of sports activities (Wu, Nien, Kuan, Wu, Chang, Chen, Chang, 2021).

Our observations and the data of other researchers show that the main directions for improving the technical training of athletes of this sports specialization are the use of training simulators that can be useful at all stages of their sports training (Taha, et al.; Ariffin et al. 2018). Among the works devoted to the application of technical means in the organization of the process of training athletes in archery, there are works in which an attempt to systematize the technical means of archers is very concisely presented and a table of parameters, registration methods and types of devices in archery is provided. In this study, the application of the technical simulator "Posture Practice", "Elbow Pad" provides an opportunity to master the models of the technique in the conditions of the environment in which the athlete will realize his strength potential (Platonov, 2015; Yu, Chen, Chiu, Chen, 2021). Such simulators make it possible to significantly intensify the process of improving the athlete's technical skill, a significant ( $p < 0.05$ ;  $p < 0.01$ ) increase in the results of the competitive exercises "Archery 18 m" and "Archery 60 m" at the end of the experiment testifies about the positive impact of using these simulators on the technical training of archers.

The obtained results of the study indicate that it is necessary to pay attention to the performance of exercises on training simulators, which involve long and repeated repetition of the ready posture and maintaining it for a certain time, these actions are aimed at adapting the archer's body to specific loads. It is also necessary to perform exercises aimed at ensuring the coordinated actions of numerous muscle groups of the back, the hand that directly performs the tension of the bow, and the hand that ensures the retention of the bow and counteracts its pressure. The development of coordination abilities lays the foundation for the further development of accurate perception and reproduction of muscle efforts, as well as the ability to differentiate time, speed and power characteristics in the set of movements that provide a shot, therefore, the development of the ability to effectively manage muscle tension and relaxation is necessary. The manifestation of strength abilities is closely related to the efficiency of the energy supply of the corresponding work, the level of development of speed abilities and flexibility, they are necessary for holding the bow and resisting its pressure, as well as for stretching the bow, therefore special strength is developed in relation to the technical actions performed by the archer.

## Conclusions

A description and characteristics of training simulators "Posture Practice", "Elbow Pad", "Balance Board" for the development of physical qualities and techniques of archers are given. It was revealed that, as a result of the experiment, the experimental group's scores of 5 tests increased after the experiment: "Romberg's test", "Long jump from a standing position", "Holding the bow in the "stretch", "Stretching the bow within 30 s", "Archery 18 m" ( $p < 0.05$ ;  $p < 0.01$ ), in the control group, a significant improvement in the results of the test "Forward bend while sitting within 1 min" was found ( $p < 0.01$ ). After the experiment, reliable differences were found between the control and experimental groups. According to the results of the tests "Shuttle run 4x9 m", "Stretching the bow within 30 s", "Archery 18 m", "Archery 60 m" ( $p < 0.05$ ;  $p < 0.01$ ) in the experimental group, these indicators are significantly higher compared to athletes of the control group. The results of the research that were obtained make it possible to expand both the theoretical and practical basis of the training process of archers, to specify some parameters of the educational and training load when using training devices, which leads to the improvement of sports results in athletes.

**Conflicts of interest.** The authors have no conflicts of interest.

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