

• **ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ У ФІЗИЧНОМУ ВИХОВАННІ
І СПОРТІ. БІОМЕХАНІКА ТА КІНЕЗІОЛОГІЯ**

• **INFORMATION TECHNOLOGIES IN PHYSICAL TRAINING
AND SPORT. BIOMECHANICS AND KINESIOLOGY**

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**FORMATION OF THE TARGET ACCURACY
FOR HIGHLY SKILLED SHOOTERS
USING MECHANICAL OBSTACLE-FACTORS**

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ФОРМУВАННЯ ЦІЛЬОВОЇ ТОЧНОСТІ У ВИСОКОКВАЛІФІКОВАНИХ СТРІЛЬЦІВ ІЗ ВИКОРИСТАННЯМ МЕХАНІЧНИХ ЧИННИКІВ-ЗАВАД. Богдан ВІНОГРАДСЬКИЙ. *Львівський державний університет фізичної культури, Львів, Україна*

Анотація. Для теорії та практики стрілецького спорту важливо визначити вплив механічних керованих впливів чинників-завад на показники спеціальної підготовленості і спортивної результативності у кваліфікованих стрільців.

Мета роботи полягала в удосконаленні процесу підготовки висококваліфікованих стрільців на основі встановлення закономірностей впливу керованих механічних чинників-завад на параметри точності й спортивну результативність стрільців високої кваліфікації.

Упродовж проведення педагогічного експерименту зі стрільцями високої кваліфікації послідовно простежували динаміку параметрів спеціальної підготовленості стрільців, у тому числі і кінематичної точності рухових дій, із поетапним моделюванням визначених зовнішніх умов.

Установлено типологічні варіанти механічних додаткових навантажень зовнішніх чинників-завад на систему «стрілець – зброя». Їх доцільно розподіляти на постійні та варіативні у двох режимах: імпульсному та синусоподібному. Запропоновано відповідні педагогічні форми реалізації додаткових механічних зовнішніх навантажень у спортивній практиці стрільців високої кваліфікації. У результаті проведення експериментальних досліджень із використанням зовнішніх варіативних механічних навантажень зафіксовано істотне поліпшення двох кінематичних показників мікрорухів, а також середньої результативності стрільців.

Ключові слова: стрільба, моделювання, надійність, рухові дії, цільова точність.

Problem statement. Shooting sports refers to accurate types of human motor activity, where the accurate-targeted actions have a complex multi-level system of organization. These actions are characterized by a certain degree of reliability as influenced by the large number of endogenous and exogenous obstacle factors. Hence, the obstacle-resistance operation of functional systems with high accuracy in the shooting sports is an integral part the theory of reliability. A high obstacle-resistance of the system under the obstacle factors influence is defined as the ability of the system to work under obstacle factors conditions without loss of efficiency or deteriorating of target accuracy [2, 6, 9]. Considering the variability of the external environmental conditions, variation of obstacle factors effects, and necessity to preserve and even improve the accuracy in target shooting, as well as fragmentariness of relevant theoretical knowledge and practical skills in methodology and technique of preparation to a problem, experts need to pay much more attention here [8, 12].

Analysis of recent researches and publications. A large number of research papers refers to the study of human activity under the condition of obstacle factors. These works are carried out in different areas of knowledge and practical activity. The problem of obstacle resistance is well-studied in space psychology and medicine, where human activity occurs in extreme conditions such as hypokinesia, hypoxia, weightlessness, etc. In sports activities an athlete is influenced by a number of obstacle-factors. The works of I.P. Ratov, A.A. Novikov, S.V. Erdakov, A.V. Ivoylov, V.E. Borilkevich had shown that a progressing exhaustion is one of the most important stimulus leading to a non-coordination of functions and movements of an athlete [3, 4, 14]. In this case the duration of

support and unsupport phases while running, the magnitude of force when pedaling, biodynamic structure of a fighter's technique, an exactness of hit in fencing and throwing the ball in the basket will be broken. In numerous studies of A.V. Ivoylov and co-authors were found that the most sensitive indicators to an action of endogenous and exogenous factors is a qualitative performance of accuracy-targeted movements and the overall sports effectiveness associated with them [5]. The latest scientific researches concern a modeling of the external environment with the use of obstacle-factors generated by specialized devices during training of shooters. Therefore it is important to determine the influence of mechanical controlled obstacle-factors on special preparedness and sports performance of skilled marksmen [7, 10].

The work has been performed according to the "Consolidated plan of research work in the field of physical culture and sports in 2011 – 2015" Department of Education and Science, Youth and Sports of Ukraine: "Modeling of biomechanical systems in complicated coordinating sports", type 2.17 (state registration № 0111U006473).

The objectives of the work is to improve the process of qualified shooters training by establishing a regularity of the influence of controlled mechanical obstacle factors on their accuracy and athletic performance.

Research objective:

- 1) systematize variants of mechanical obstacle-factors influence on the system "shooter – weapon";
- 2) describe the change of parameters accuracy in motor action of high qualified shooters under the influence of controlled mechanical obstacle-factors;
- 3) determine the regularity of sports performance dynamics of high qualified shooters due to the nature of mechanical obstacle-factors.

Methods and studies organization. Main methods: analysis of literature and practical experience of training of the leading shooters of Ukraine, pedagogical observation and content analysis of preparation process of highly qualified shooters of Ukraine, pedagogical experiments with the use of controlled additional mechanical loads generated by obstacle-factors, optic-electronic fixation of kinematic accuracy of motor actions; mathematical and statistical analysis of the data.

More than one hundred shooters aged 17–35 were involved in the pedagogical experiments in different kinds of sporting weapons. Athletes were qualified not lower than masters of sports, and more than 20 of them formed national teams of Ukraine in different types of shooting sports. The pedagogical experiment lasted for two Olympic cycles. During this time we traced back the dynamics of marksmen's special preparedness parameters with step by step modeling the defined environmental conditions. Each stage of the experiment lasted in the range of 4 to 10 weekly micro cycles.

The main material of the research. During the competitive outdoor activities the system "shooter – weapons" is affected by a significant number of external factors. Some of them have a rather negative effect. Others are neutral.

A shooter must be ready to the negative impact of such factors. Their activity should be "neutralized" or degree of impact minimized. So a certain adaptation resources must be created for an athlete in advance for a significant decrease of obstacle-factors.

Thus, there should be traced an algorithm for creating functional reserve of an athlete's body.

This algorithm can be characterized by the following steps: opening features of natural and artificially-created environment for training and competitions; establishing of the essential motor actions according to an impact on accuracy and sports result of shooters under obstacle-factors; determining the typological mechanical features of obstacle-factors, creating the pedagogical techniques, tools, methods and technical solutions from the modeling of defined mechanical impacts, establishing the effectiveness of the offered didactic approaches during the respective pedagogical experiments; hypotheses examination on the effectiveness of pedagogical ways of increasing highly skilled marksmen body's adaptive resources during prolonged observation for several events.

Thus the environmental conditions, in which the athlete is competing, are marked by its diversity and significantly affect the mechanism of achieving the sports result. Knowing biomechanical regularities of interaction athlete's body with environmental factors, it is possible to consider the

main mechanical factors of influence the environment on the athlete and on this basis develop pedagogical tools, and if necessary the appropriate training devices that allow artificially simulate natural conditions for sports activities performance.

The result of the analysis of specialized literature and proper theoretical and practical studies is a typology of features of external didactic environments. There are three different forms: 1) artificial controlled environment [13], 2) objective environment [11], 3) simulated environment [1].

The theory of "controlled artificial environment" that has been developed by I.P. Ratov has two components. The first one is the creation of artificial conditions in time of performance a variety of sports exercises, during which it is possible to sharply limit the impact of factors that block "full competitive variant" to perform an exercise. The second component is an elimination of natural forces shortages aimed to supplement energy and power applications while performing specialized movements in artificially created conditions. The H.I. Popov's applied concept of "objective environment" also contains two components. The first one is the creation of restrictions for movements of geometric and physical character. The second component is an implementation of the protective functions of the objective environment for athletes in order to be able to perform their motor actions in more intense exercise regimes.

We suggested a parallel direction of application the artificial controlled environment with a common name – simulated environment. The principal difference from the mentioned directions is a focus on the maximal approach of training conditions to competitive ones or exceeds its requirements. Indeed, there is a significant number of factors under which training can not even approximately replace the impact of competitive factors on an athlete.

If we systematize common mechanical obstacle-factors impacts on the "shooter – weapons" system we obtain at least three variants. The first one is the effect of sine pulse power, or in the other words "soft alternating mechanical variant". The second one is the effect of saw pulse power – "hard alternating mechanical variant". The third one is an action of a permanent additional component pulse power – "sustainable mechanical variant" (Fig. 1).

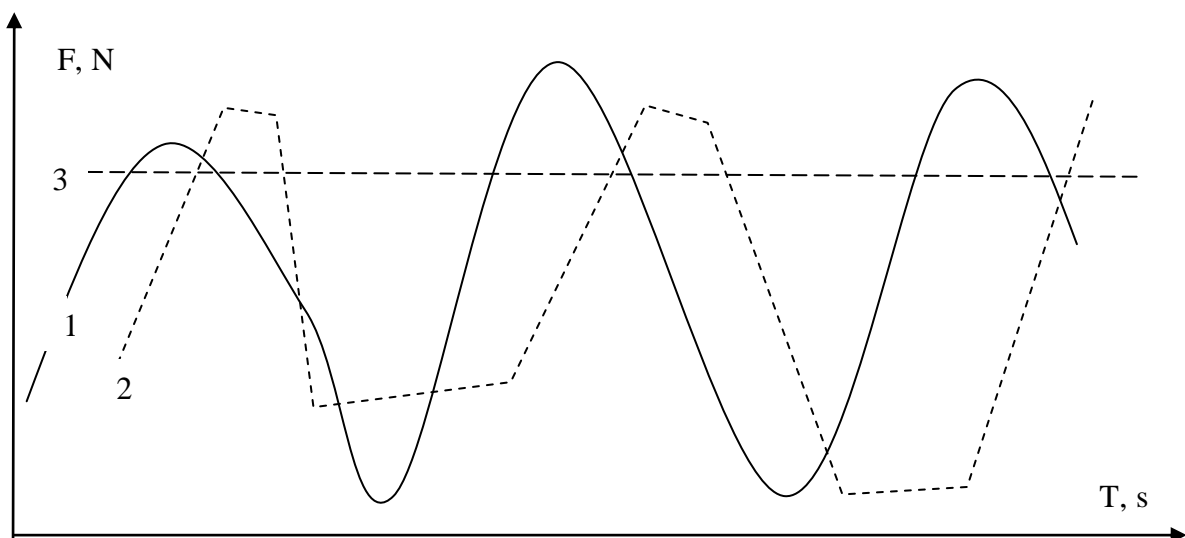


Fig. 1. Typical variants of mechanical noise-factors impact on the "shooter – weapons" system

Taking into account the foregoing, we have offered the appropriate forms of artificial environment realisation in shooting sports, which model three types of mechanical obstacle-factors. These primarily include the modeling of additional wind loads (sinusoidal "soft" variable loads during the application of wind turbines or impulse "hard" variable loads during the application of spring-mathematical pendulum), the modelling of supergravity conditions (additional permanent loads), modeling of additional power of the removal an anthropo-technical system out from the balance (intermediate version).

So, we suggested several technical solutions that contribute to the modeling of mechanical effects of different types of obstacle-factors. In particular, the wind is one of the significant effects on

sports performance in archery. Its main summarized features are character of an impact which is variable and unstable in strength and direction, the practical impossibility of modeling this factor in terms of training conditions, parallel action of physical and mental component.

For practical implementation of windy weather conditions an appropriate computer device for representation of such circumstances was developed. The component units of the device are a personal computer with an installed program, an interface to perform the functions of information exchange between the PC and two digital-to-analog converters, which generate and send control signals to the devices that are turbines that determine the direction and speed of the air flow.

An alternative and simpler variant for practical realization of modeling the wind effect is a mechanical oscillatory system. This is a joint spring-mathematical pendulum that moves in a vertical plane under the influence of two forces-gravity and elasticity.

Recently, in sports practice a biomechanical stimulation in a gravitational workout form has been widely spread. The basis of the offered technique is the application of the device, construction of which is performed in a form of a special overall. The use of overalls allows simulating conditions of increased gravity (+7% to +9%). The device has a loads system that are located in a way that a sportsman could preserve the natural geometry of the body masses during the module change of the gravitational interactions, which are important for the implementation of the regulated training program for the increase of force capacity of muscles. The use of such device allows to fully reproduce in the didactic process those conditions of gravitational interactions that athletes must implement to improve a particular kinematic and dynamic structure of movements in shooting required to achieve a high target accuracy.

Another area for implementation of an artificial simulated environment in shooting sport is an increase of the high posture-static stability, which is provided by a gradual adaptation to maintaining posture in complicated conditions, which is typical for shooting sports. We used several variants of conditions complication. It should be noted that the choice of a variant depended not only on the objective characteristics of the use of specialized exercises, but also on subjective difficulties, primarily the psychological ones.

It is reasonable to compare the impact of different mechanical obstacle-factors that materially simulate training and competition environmental conditions on changes in the rate of motor accuracy and sports performance of the shooters during the pedagogical experiments. With a large number of motor and target accuracy parameters that affect the sports result, the rates with the greatest value of statistical connection were analyzed.

The previous studies showed that these rates were the sighting accuracy (mm), medium resistance to "10", (s), retention time of the sighting point in a target circle \varnothing 20 mm (s).

The recorded data of fixed parameters before and after the pedagogical experiment were compared. Absolute significance of the differences of each parameter average rate was established and Student's t-test as one of the materiality changes indicators was calculated. It is established that changes in specialized motions accuracy rates during the shot occurred in all experimental and control groups.

However, their size and nature differ significantly depending on the nature of the additional mechanical loads caused by obstacle-factors.

The shooters, who were under the influence of impulsive (hard) variable loads, achieved the greatest growth of length rate in keeping the sighting point in a circle \varnothing 20mm for an average 5.9 s. They also improved the sight accuracy to 4.6 mm and an average resistance to "10" by 0.4 s. Athletes who have been under the influence of sinusoidal (soft) variable loads significantly increased the accuracy sight to an average of 10.6 mm, and also increased the rate of the sighting point in the "10" zone by 1.5 s. The shooters, who had permanent additional load, achieved the greatest increase in keeping the sighting point in the target circle of 20 mm in diameter by 3.8 s. Archers, who were training with the use of the unstable lower support, achieved the greatest positive changes in accuracy sight rates in 8.5 mm, keeping the sighting point in the target circle of 20 mm in diameter by. Sportsmen of the control group, who had been training according to "usual" training plans in a special preparatory period of the annual cycle, had a slight increase in values of accuracy parameters of specialized motor activities (Fig. 2–4).

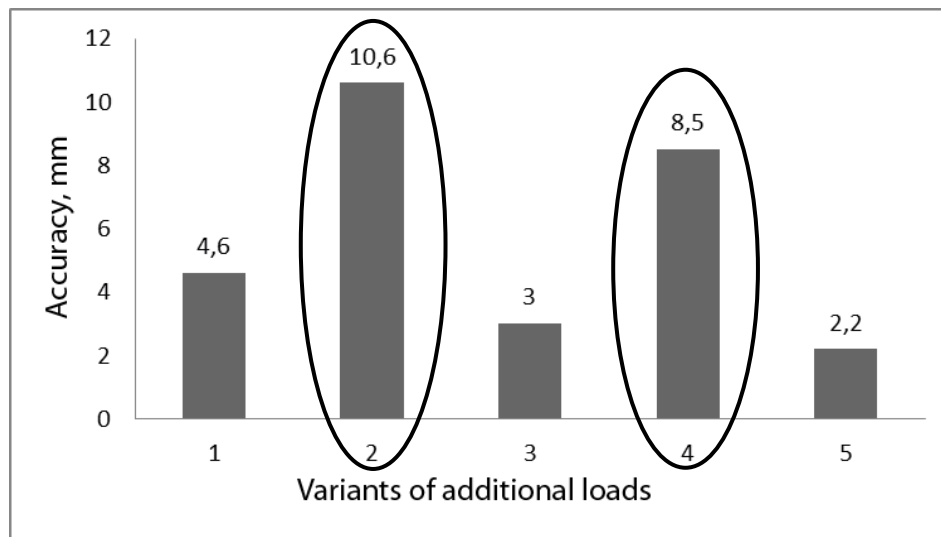


Fig. 2. Change of absolute indexes in shooters' accuracy sight after the application of additional external obstacle-factors (mm), where:

- 1 – pulse (hard) variable load;
- 2 – sinusoidal (soft) variable load;
- 3 – additional permanent load;
- 4 – unstable lower support (interim version);
- 5 – obstacle-factors missing.

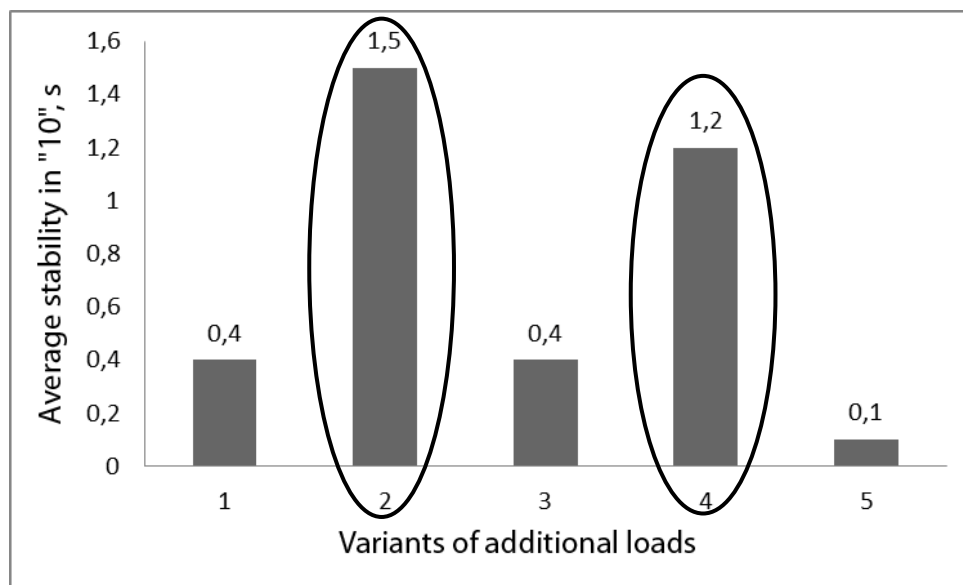


Fig. 3. Change of absolute indexes of average stability in "10" clearance of shooters' accuracy sight after the application of additional external obstacle-factors (s), where:

- 1 – pulse (hard) variable load;
- 2 – sinusoidal (soft) variable load;
- 3 – additional permanent load;
- 4 – unstable lower support (interim version);
- 5 – obstacle-factors missing.

The efficiency of noise-factors effects has been also tested in prolonged results observations in official competitions after their use in the training process. We found that almost all suggested additional types of mechanical loads on the shooter's body generated by obstacle-factors, had a positive effect on performance growth, although the nature of their influence is different (Fig. 5). In particular, there has been a rapid growth in performance after the use of sinusoidal (soft) and pulse (hard) variable loads. However, the first variant of the load shows that the performance growth is observed

not only during the first competition, but the second and third and with a slightly reduced result during the fourth as well.

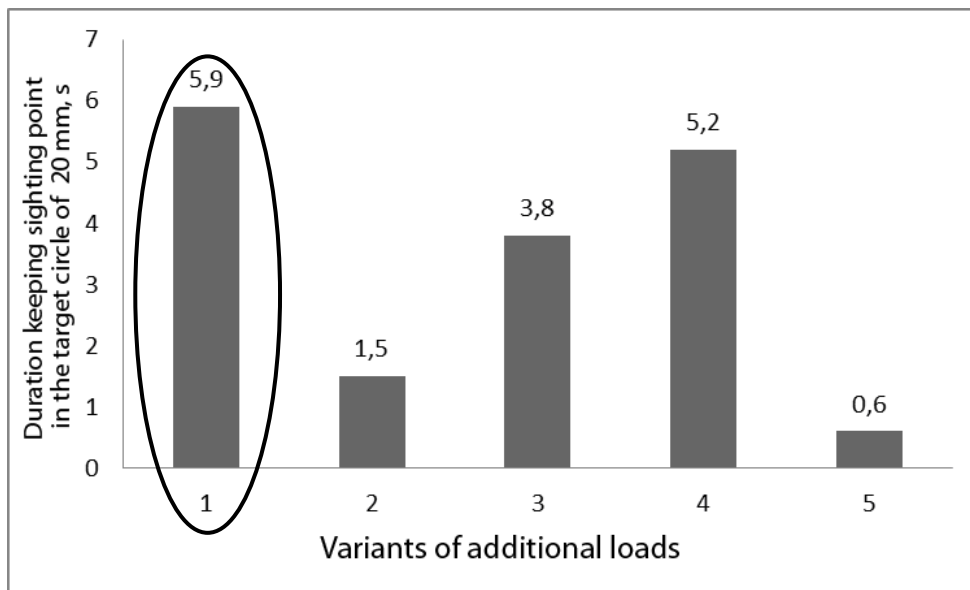


Fig. 4. Change of absolute indexes of duration keeping sighting point in the target circle of 20 mm in diameter after the application of additional external obstacle-factors (s), where:

- 1 – pulse (hard) variable load;
- 2 – sinusoidal (soft) variable load;
- 3 – additional permanent load;
- 4 – unstable lower support (interim version);
- 5 – obstacle-factors missing.

The conditions created during the use of the second variable mechanical load do not give a sustainable positive growth effect, though the changes are statistically significant if compared to the initial level ($\alpha = 0,95$). The slight, but statistically significant and sustained growth is influenced by additional permanent loads (Fig. 5).

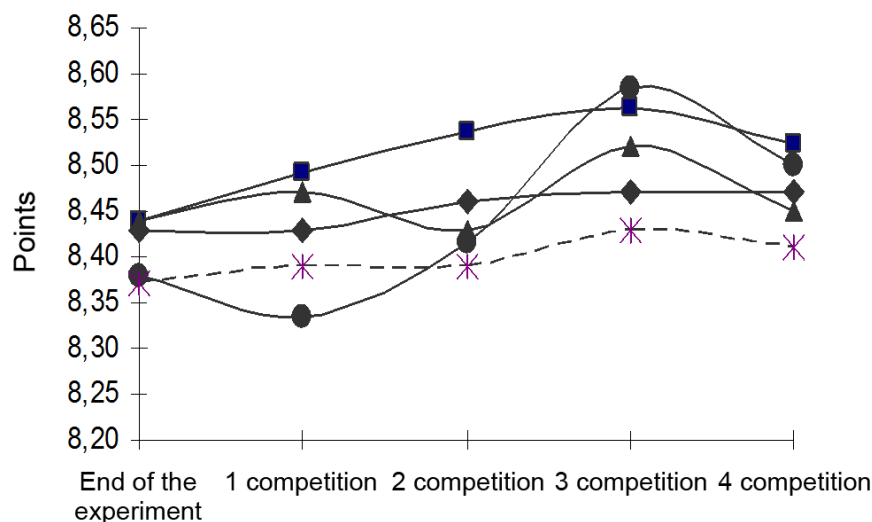


Fig. 5. Dynamics of sports performance of archers after the use of different types of additional mechanical loads:

- ▲ – after the use of pulse (hard) variable loads;
- – after the use of sinusoidal (soft) variable loads;
- ◆ – after the use of additional permanent loads;
- – after the use of unstable lower support (interim version);
- * – obstacle-factors missing.

Conclusions. There have been established typological variants of mechanical additional loads

of external obstacle factors on the "shooter – weapon" system. They are reasonable to be divided into fixed and variable in two modes: pulse and sinusoidal. There have been suggested appropriate pedagogical forms of implementation additional external mechanical loads in sports practice of highly qualified shooters.

As a result of experimental studies using two types of external variable mechanical loads, there was recorded a significant improvement of the two kinematic micro motion indexes of archers during the 18 meters length shooting indoors of medium sustainability in "10" clearance and sight accuracy. The accuracy sight grew by 7– 10 mm, and the average sustainability within the "10" clearance increased by 0.9– 1.2.

On the basis of the prolonged observations, there has been defined the regularity of sports performance dynamics of highly qualified shooters during the competitive annual cycle after the application of specialized middle cycle using different types of loads caused by mechanical obstacle-factors. It has been established that the dynamics of the average performance of shooters depends on the type of generated mechanical loads.

This dynamics is determined not only by the change of an absolute sports result in shooting, but also by the degree of stability and variability during the competitive period.

Further scientific searches should be conducted in the area of sharing use of quantitatively calculated by the volume and intensity and well-controlled mechanical obstacle-factors during the training process of the shooters.

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ФОРМИРОВАНИЕ ЦЕЛЕВОЙ ТОЧНОСТИ ВЫСОКОКВАЛИФИЦИРОВАННЫХ СТРЕЛКОВ С ИСПОЛЬЗОВАНИЕМ МЕХАНИЧЕСКИХ ФАКТОРОВ-ПОМЕХ

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Аннотация. Для теории и практики стрелкового спорта важным является определить влияние механических управляемых воздействий факторов-помех на показатели специальной подготовленности и спортивной результативности у квалифицированных стрелков.

Цель работы заключалась в совершенствовании процесса подготовки высококвалифицированных стрелков на основе определения закономерностей влияния управляемых механических факторов-помех на параметры точности и спортивную результативность стрелков высокой квалификации.

На протяжении педагогического эксперимента со стрелками высокой квалификации последовательно прослеживали динамику параметров специальной подготовленности стрелков, в том числе и кинематической точности двигательных действий, с поэтапным моделированием определенных внешних условий.

Установлены типологические варианты механических дополнительных нагрузок внешних факторов-помех на систему «стрелок – оружие». Их целесообразно разделять на постоянные и вариативные в двух режимах: импульсном и синусообразном. Предложены соответствующие педагогические формы реализации дополнительных механических внешних нагрузок в спортивной практике стрелков высокой квалификации. В результате проведения экспериментальных исследований с использованием внешних вариативных механических нагрузок зафиксировано существенное улучшение двух кинематических показателей микродвижений, а также средней результативности стрелков.

Ключевые слова: стрельба, моделирование, надежность, двигательные действия, целевая точность.

FORMATION OF THE TARGET ACCURACY FOR HIGHLY SKILLED SHOOTERS USING MECHANICAL OBSTACLE-FACTORS

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Abstract. For shooting sport theory and practice it is important to determine the influence of mechanical controlled obstacle factors on the indexes of special preparedness and athletic performance of skilled shooters.

The objective of the work was to improve the training process of qualified shooters by estab-

lishing a regularity of the influence of controlled mechanical obstacle factors on the accuracy and athletic performance of highly qualified shooters.

During the pedagogical experiment with highly qualified shooters the dynamics of special preparedness of the shooters was consistently observed as well as the kinematic accuracy of motor actions with a step-by-step modeling of the definite environmental conditions. Typological variants of additional mechanical loads of external obstacle factors on the “shooter – weapon” system were established. They are expedient to be divided into fixed and variable in two modes: impulsive and sinusoidal.

Appropriate pedagogical forms of realization additional external mechanical loads were offered in sports practice of highly skilled shooters.

As a result of experimental studies using external variable mechanical loads, a significant improvement of the two kinematic micro motion indexes as well as the average efficiency of shooters was recorded.

Keywords: shooting, modeling, reliability, motion, target accuracy.

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